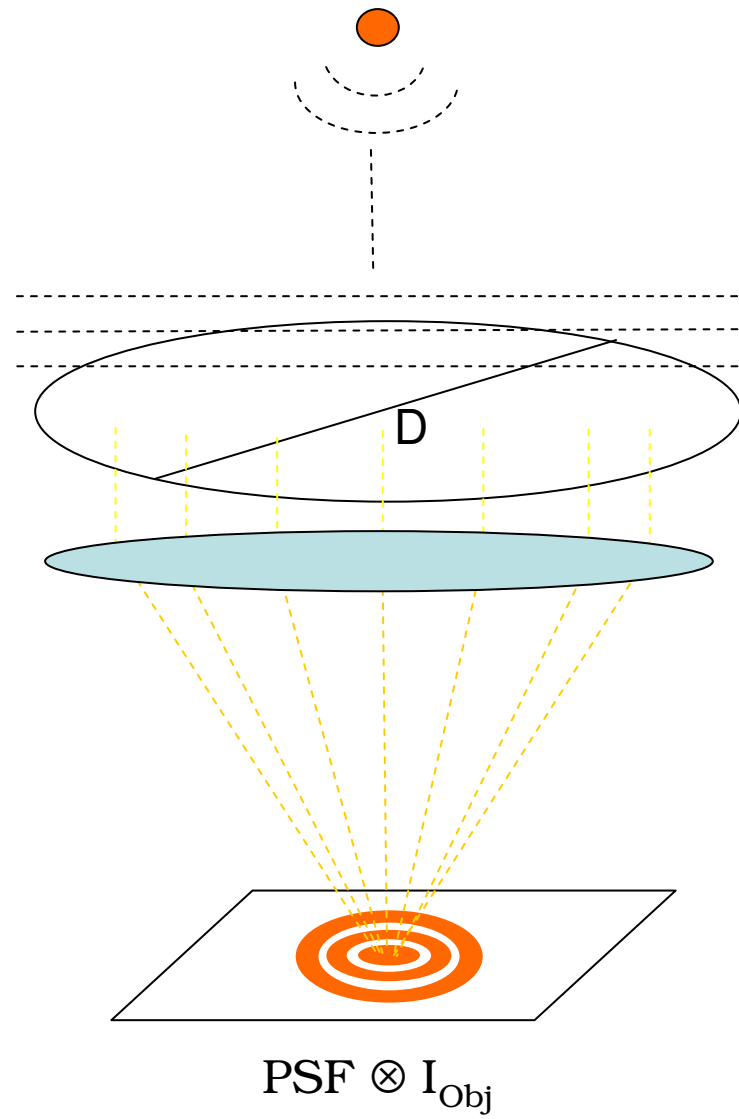


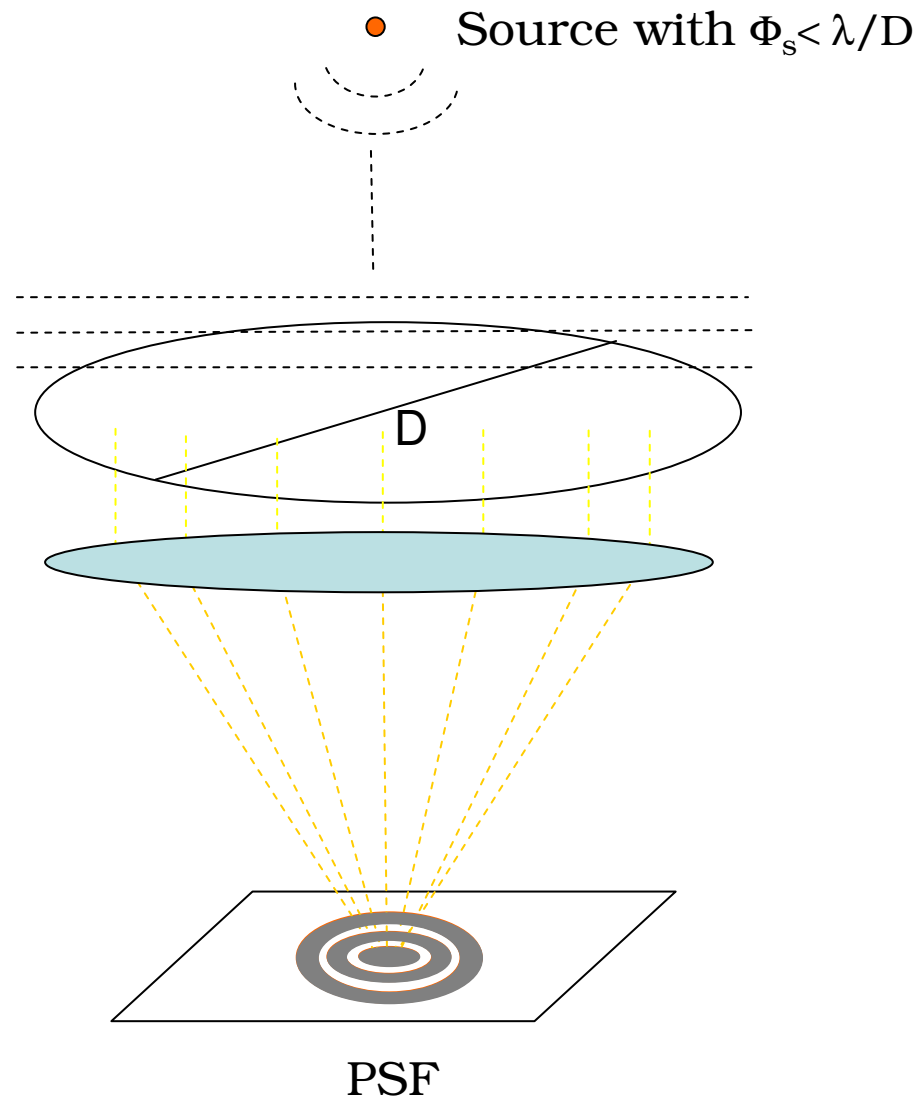
Basics of Optical Interferometry

(Observational Astronomy II)
Lecture by Stéphane Sacuto

Power of Resolution and need for High Angular Resolution



Power of Resolution and need for High Angular Resolution



The information on your object is lost.
You **NEED** more spatial resolution from your instrument.

Required monolithic telescope diameters

| Objects | Wavelength (μm) | Angular size (mas) | Telescope diameter (m) |
|---|--|---------------------------|-------------------------------|
| Circumstellar envelope around α Ceti (M star) | 11 | 50 | 45 |
| Volcanoes of Io (Jupiter satellite) | 5 | 10 | 100 |
| Nucleus of NGC 1068 (AGN) | 2.2 | < 1 | > 400 |
| Spots on the photosphere of α Cen (Solar type) | 0.5 | 0.07 | 1500 |

Those structures are not resolved with monolithic telescopes
even with the ELT

We need something else

Required monolithic telescope diameters

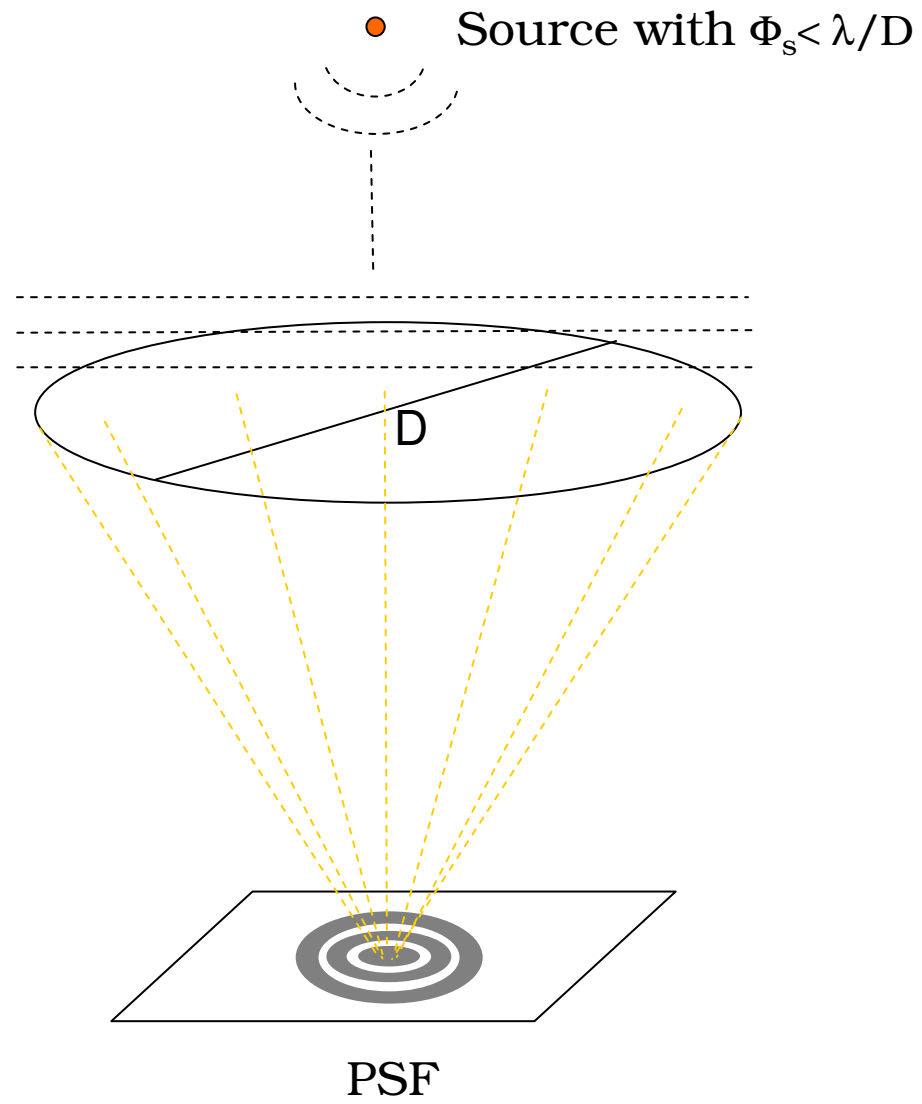
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INTERFEROMETRY

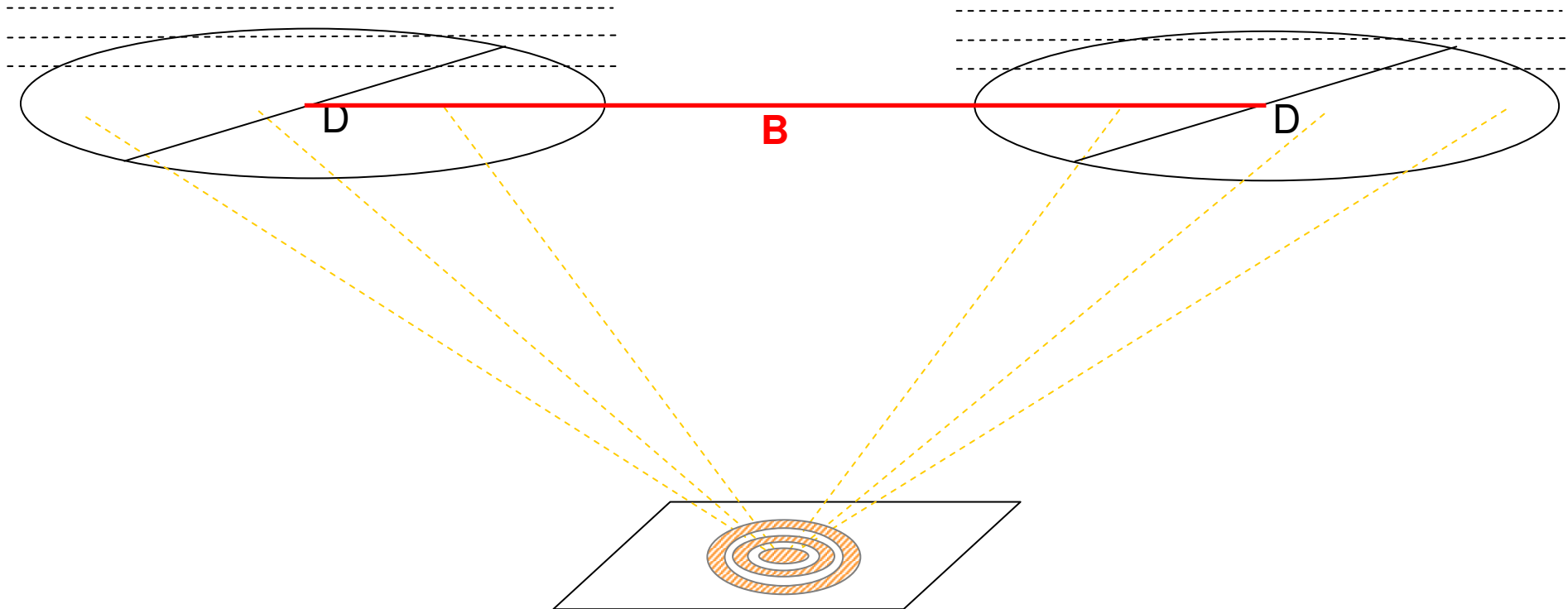
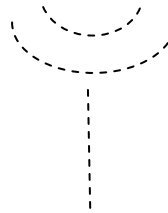
Interferometric signal



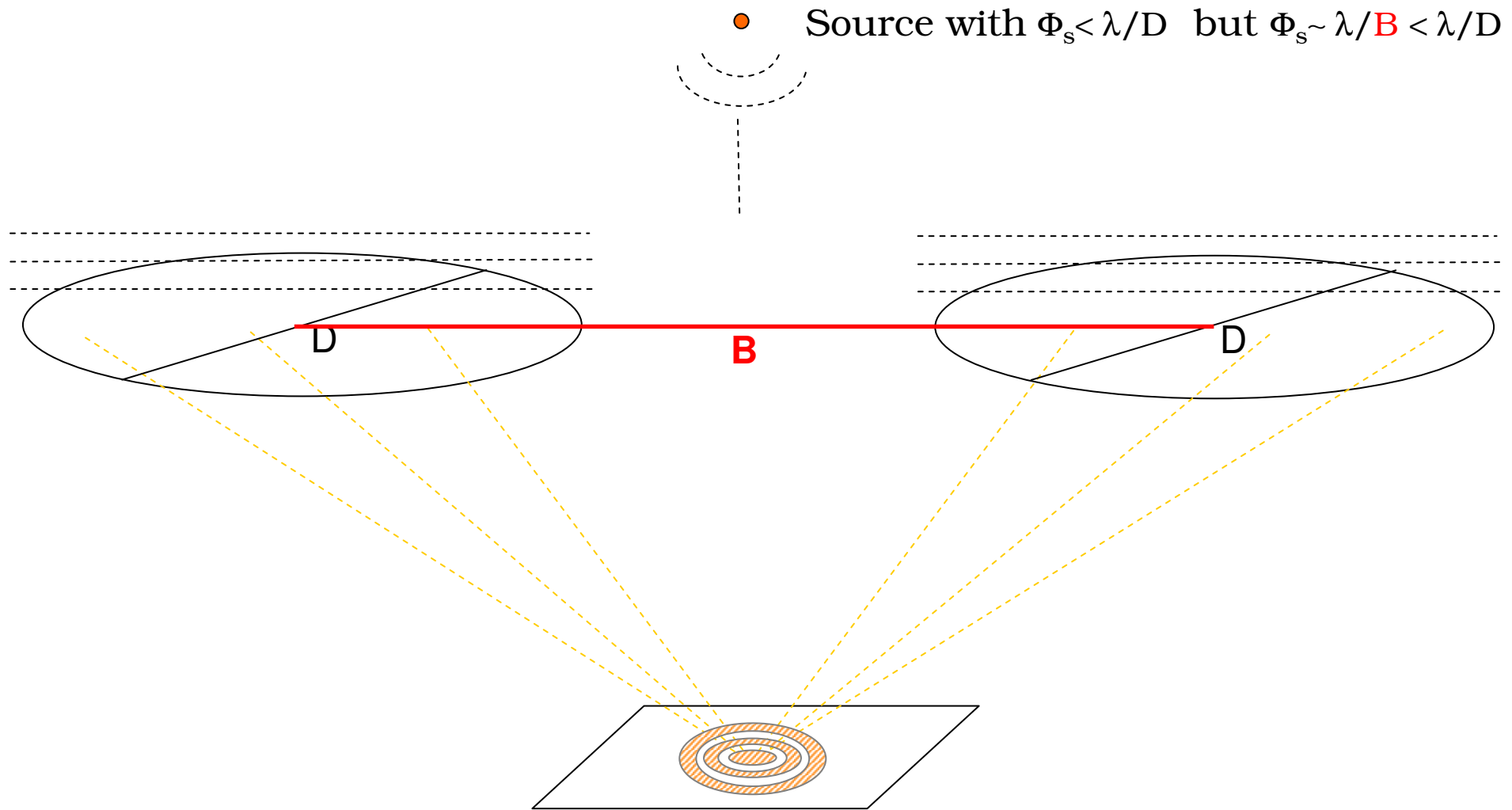
Interferometric signal



Source with $\Phi_s < \lambda/D$ but $\Phi_s \sim \lambda/\mathbf{B} < \lambda/D$

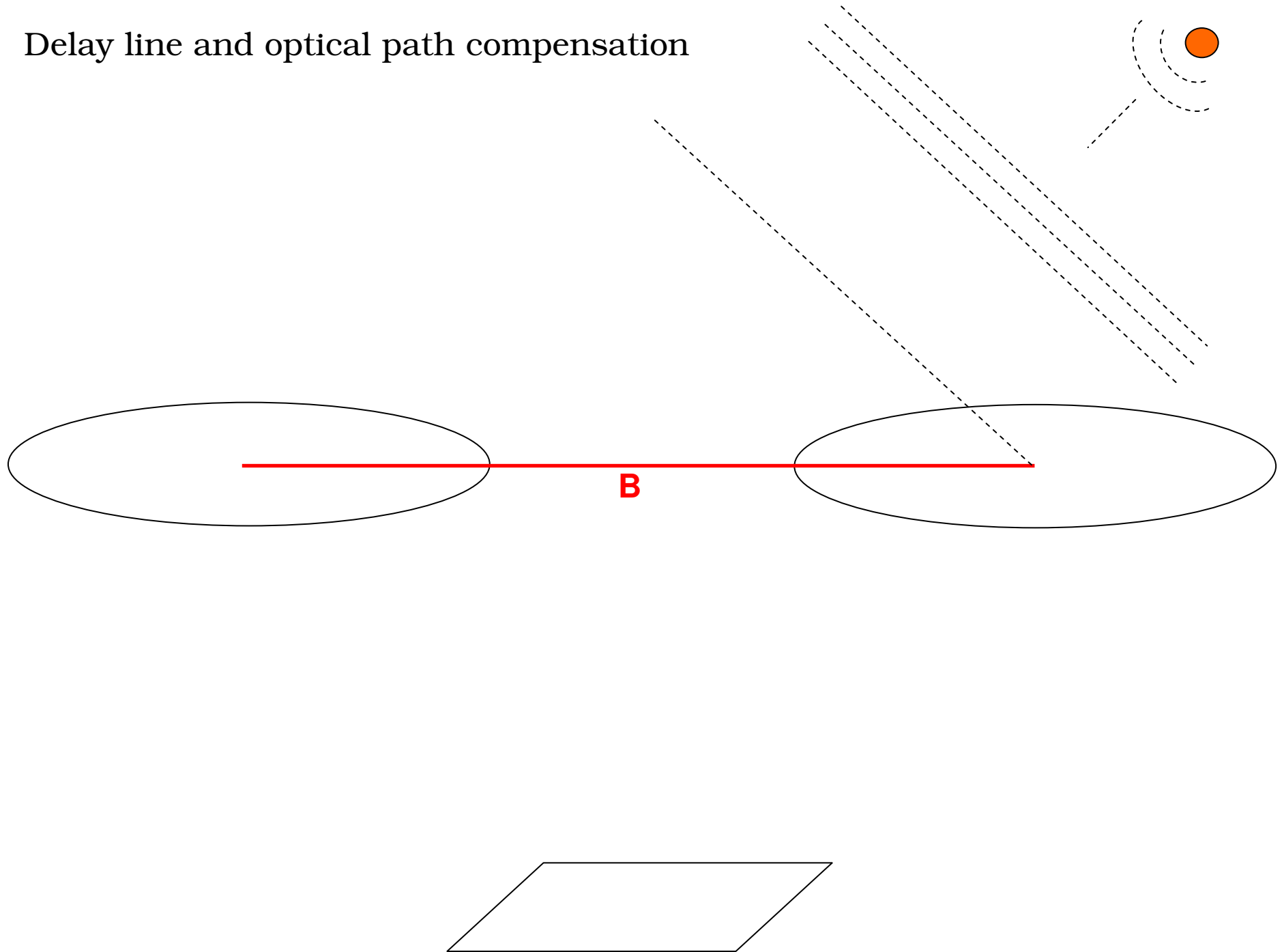


Interferometric signal

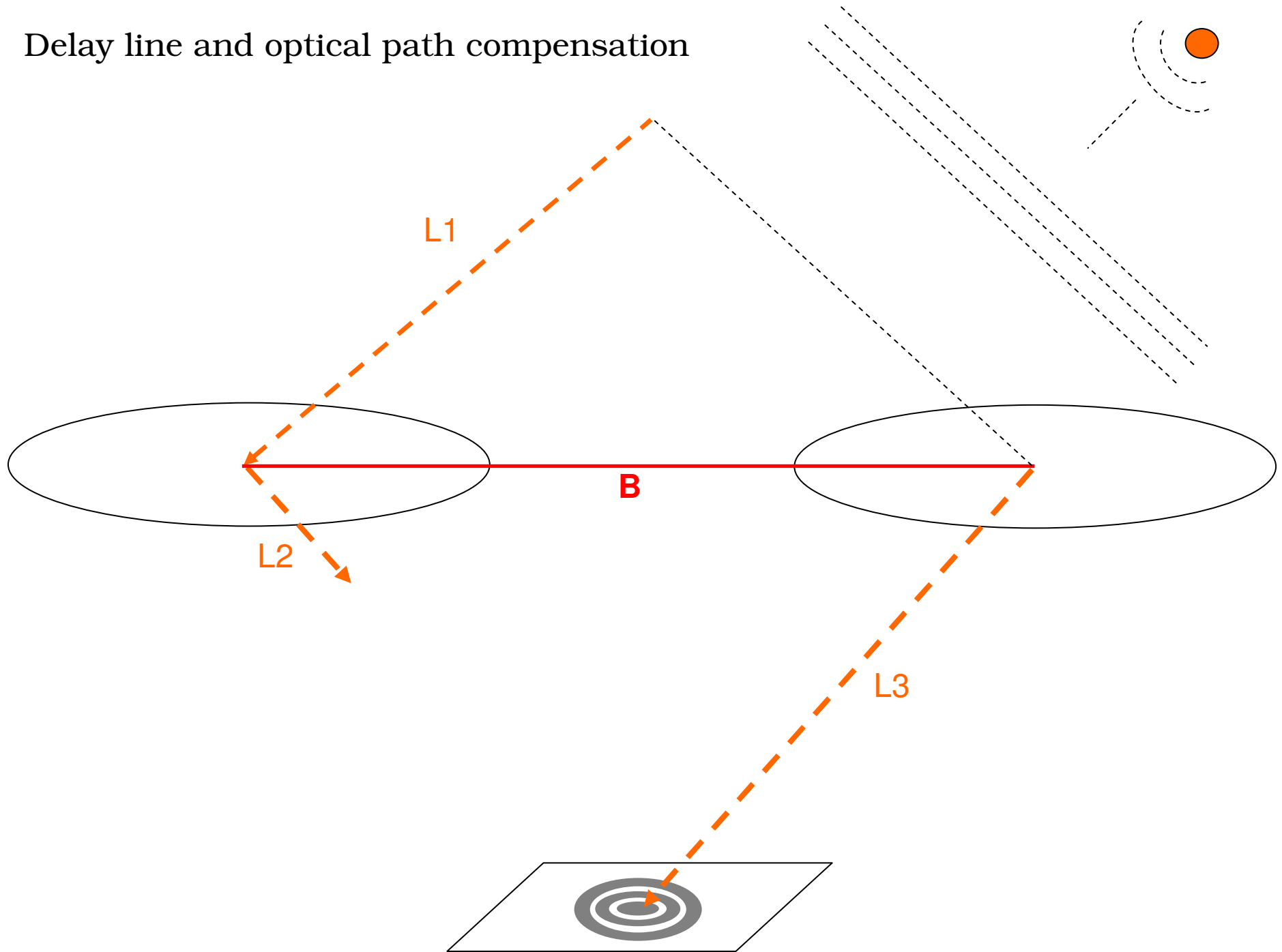


The signal of the source is found again but under the appearance of fringes

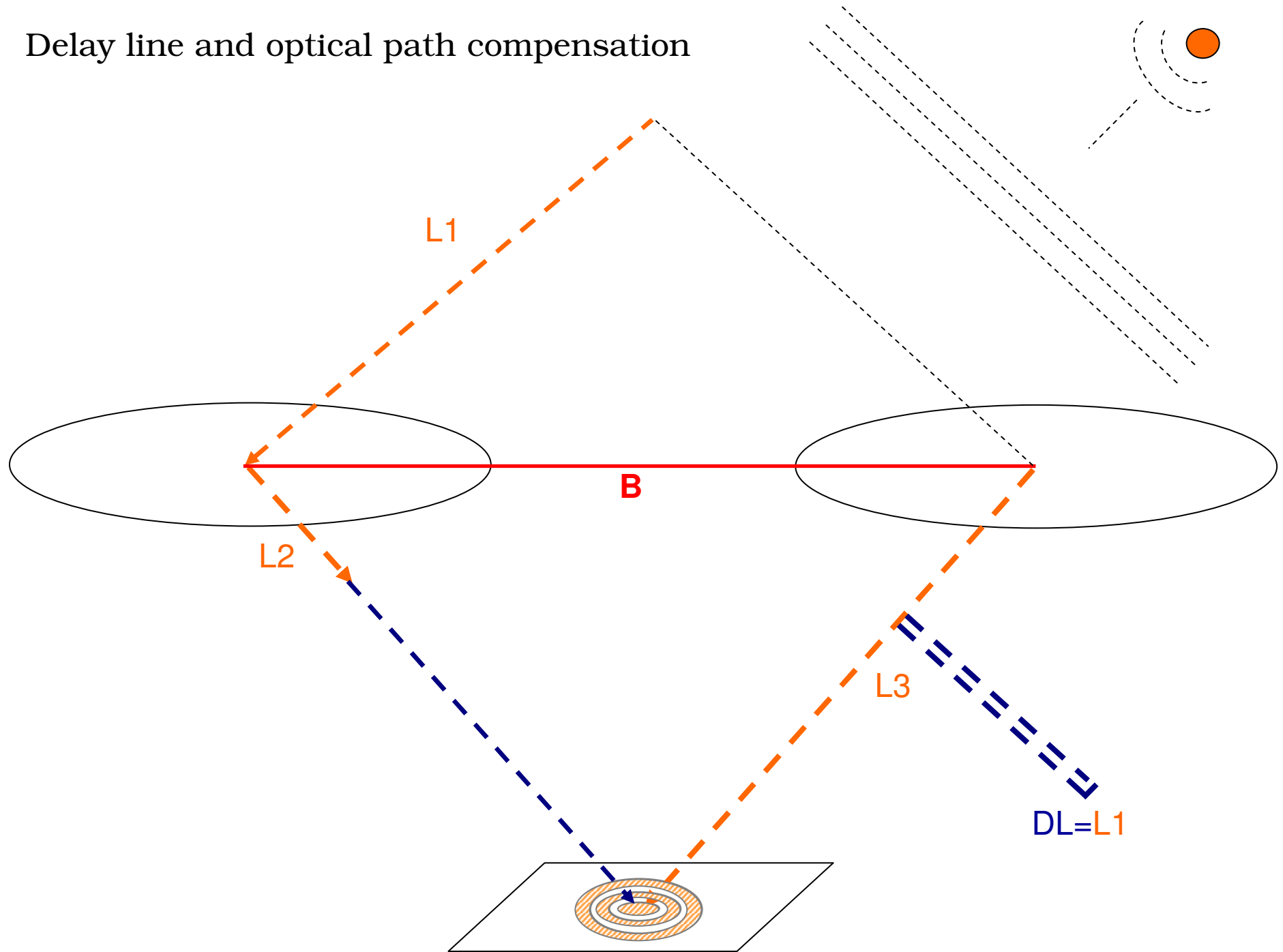
Delay line and optical path compensation



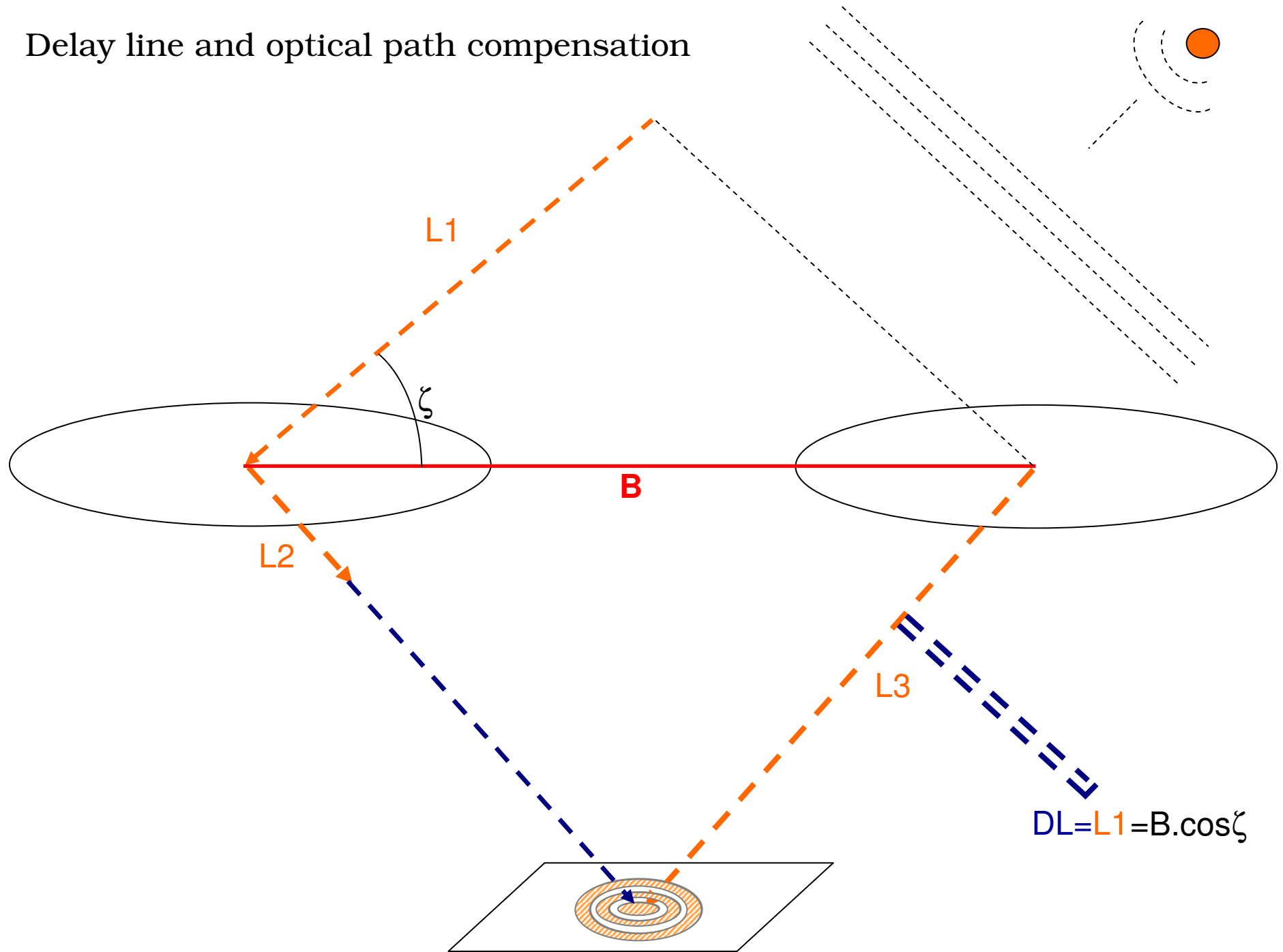
Delay line and optical path compensation



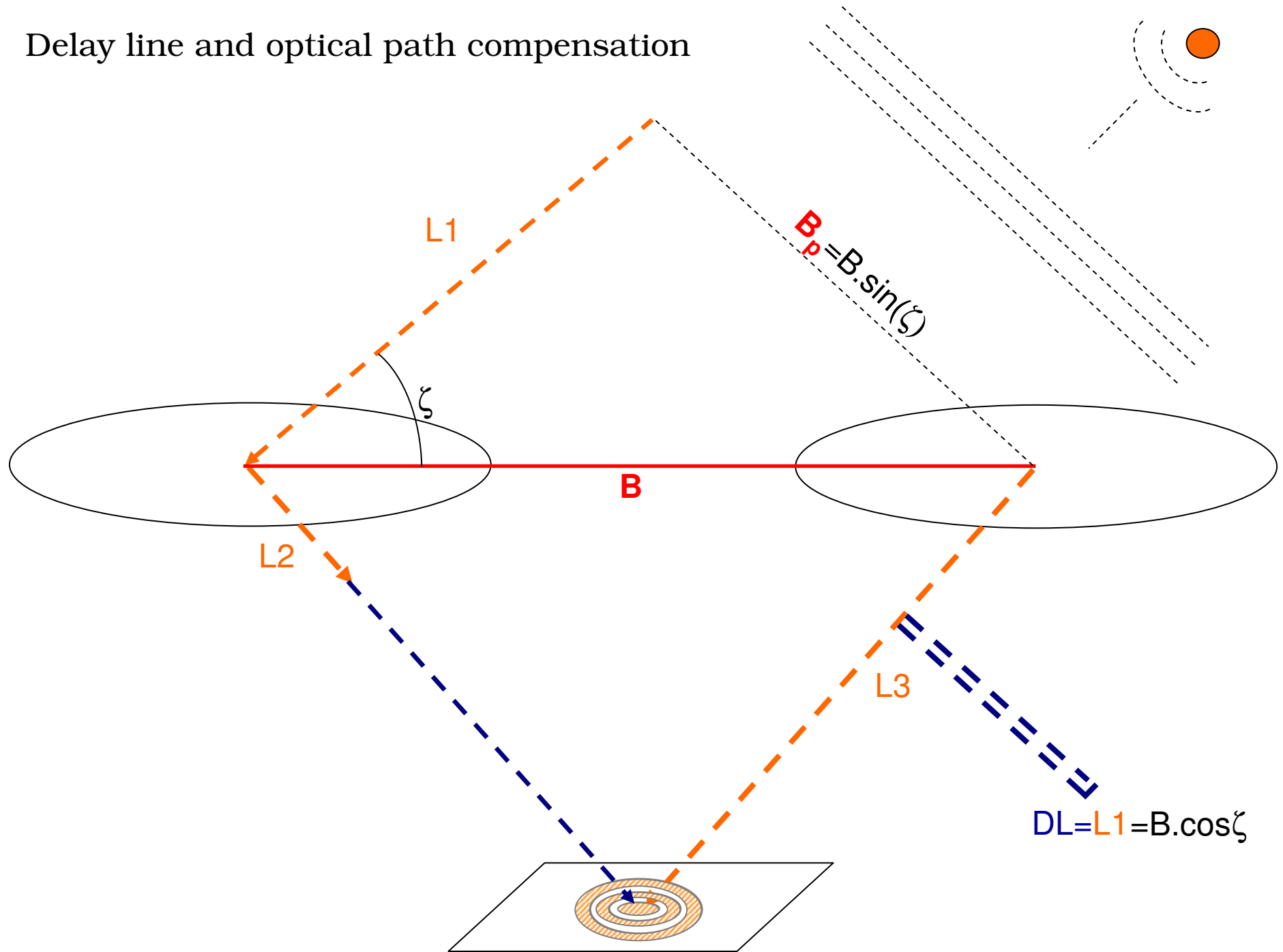
Delay line and optical path compensation



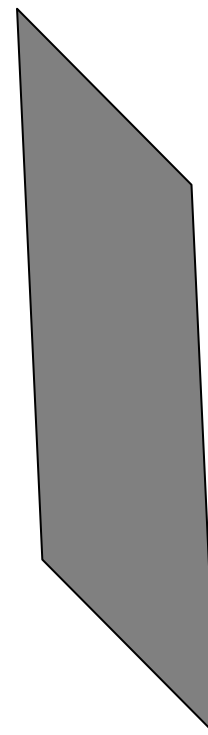
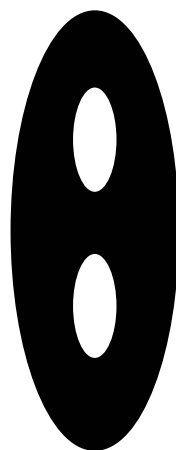
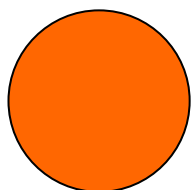
Delay line and optical path compensation



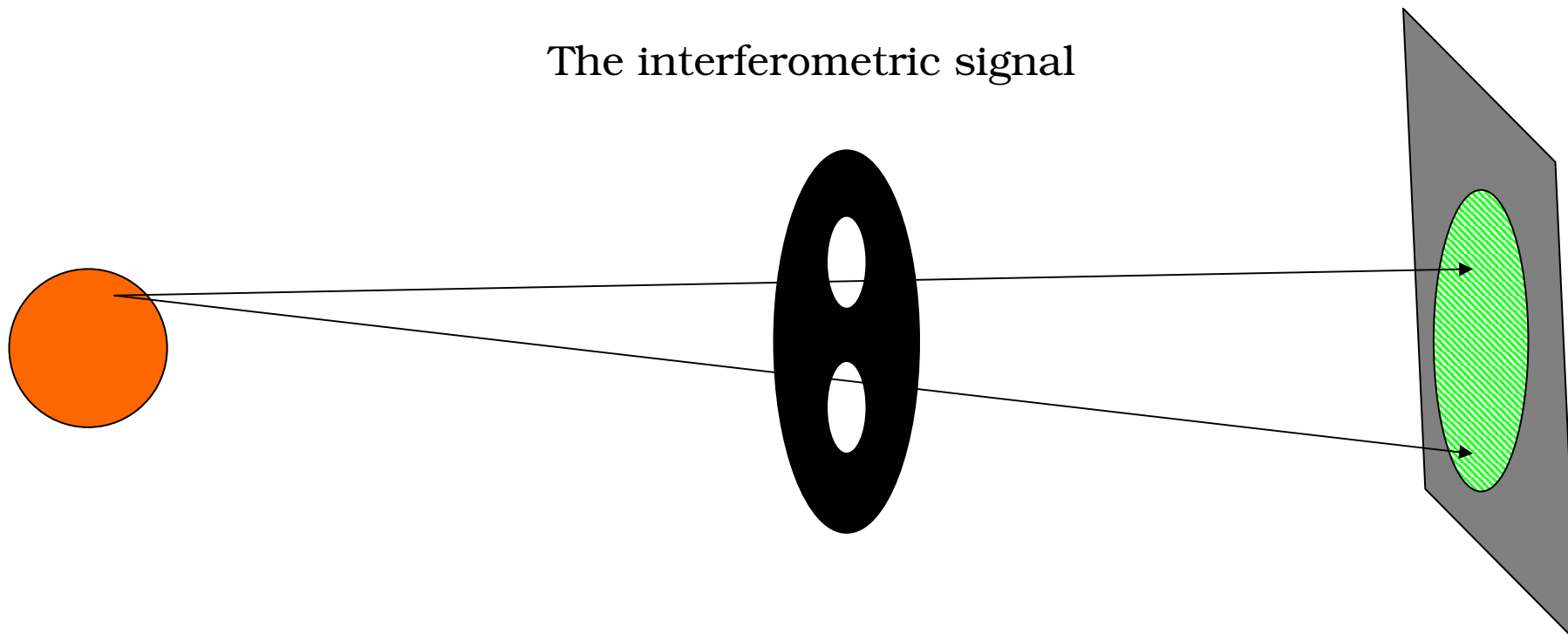
Delay line and optical path compensation



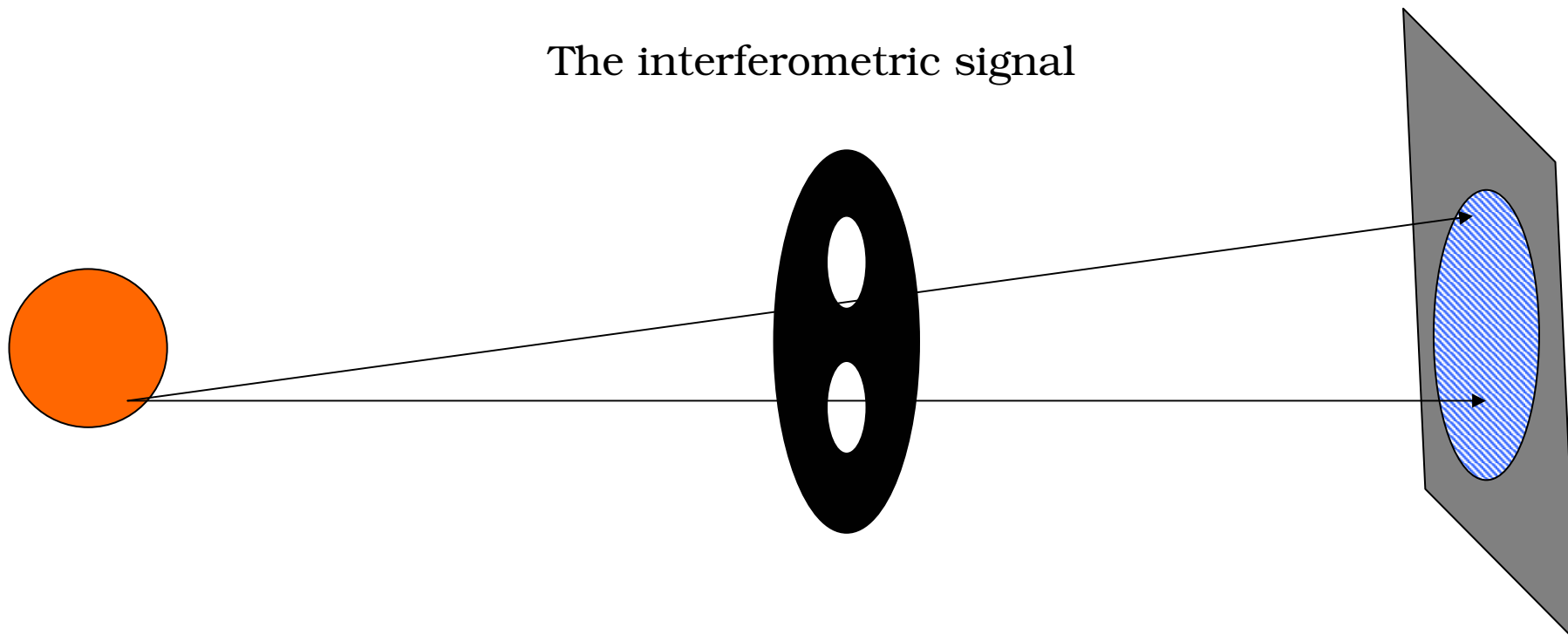
The interferometric signal



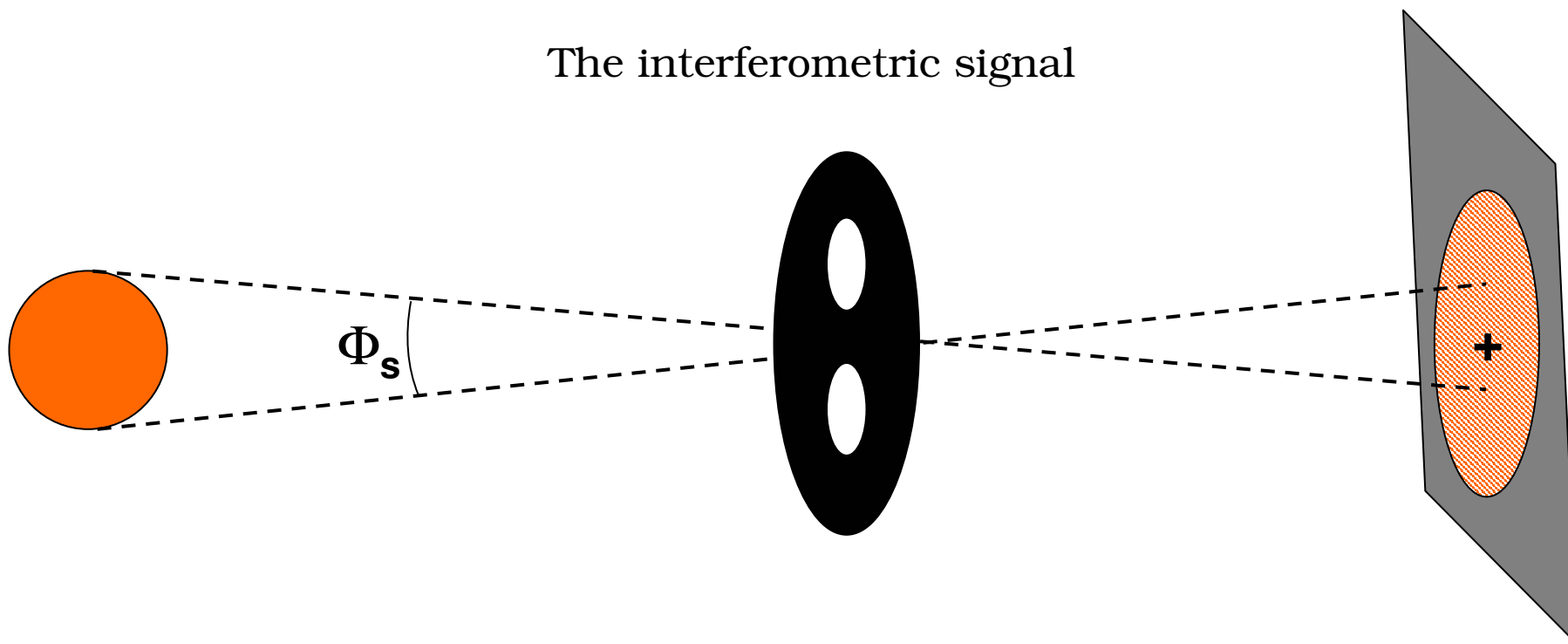
The interferometric signal



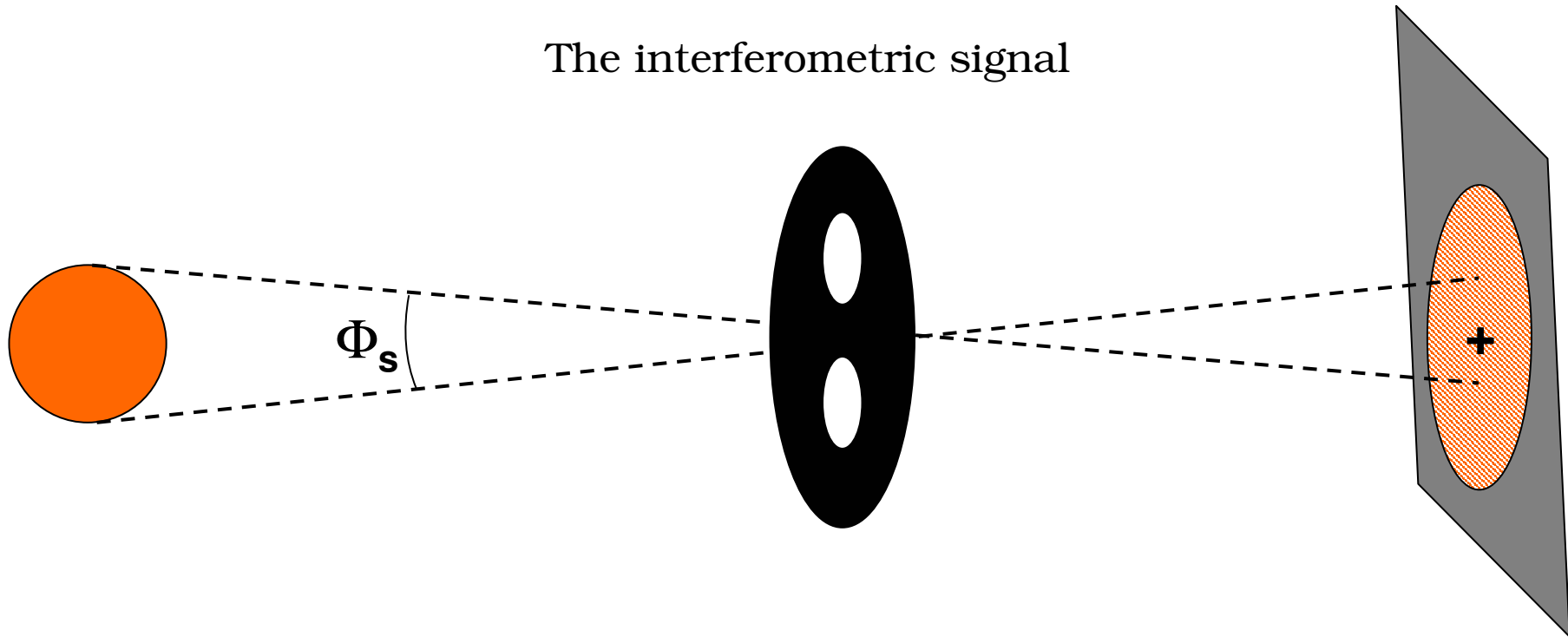
The interferometric signal



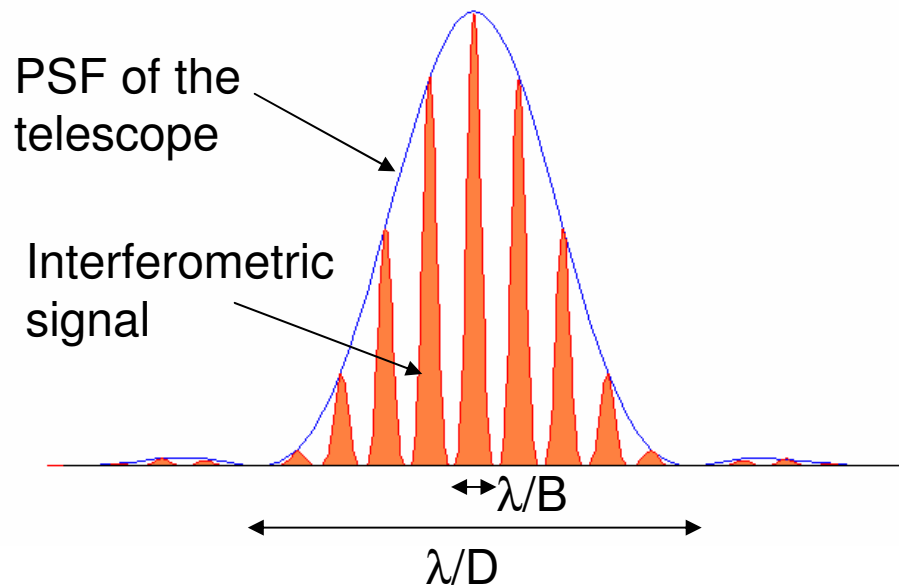
The interferometric signal



The interferometric signal



An Interferometer is measuring the contrast of the total fringe pattern :



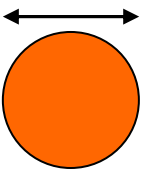


Fringe contrast is given by :

$$V = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

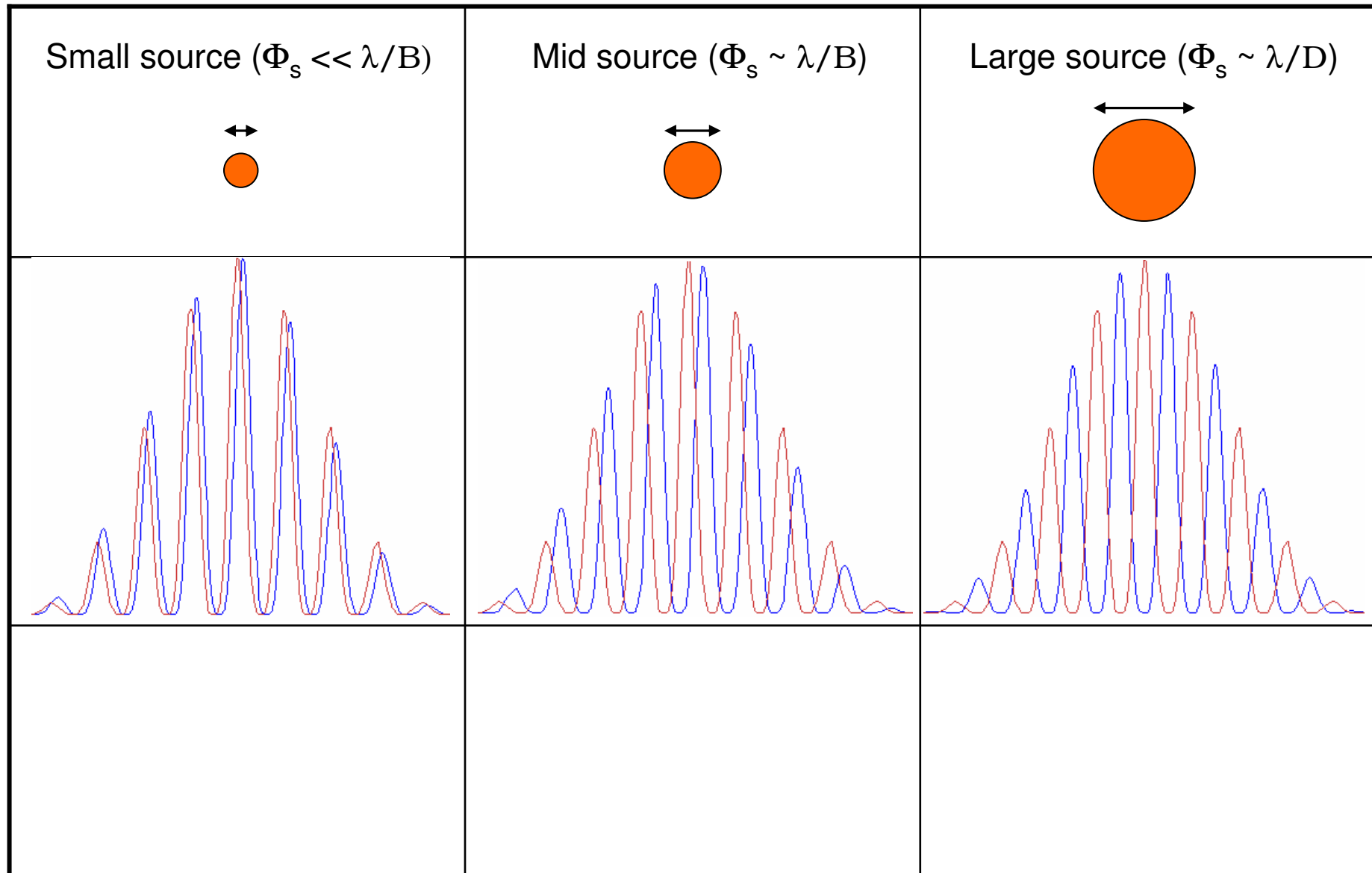
The fringe contrast (part I)

□ For a given baseline length B and for different sizes of the source Φ_s

| Small source ($\Phi_s \ll \lambda/B$) | Mid source ($\Phi_s \sim \lambda/B$) | Large source ($\Phi_s \sim \lambda/D$) |
|---|---|---|
|  |  |  |
| | | |
| | | |



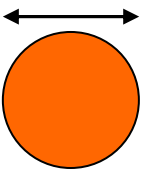
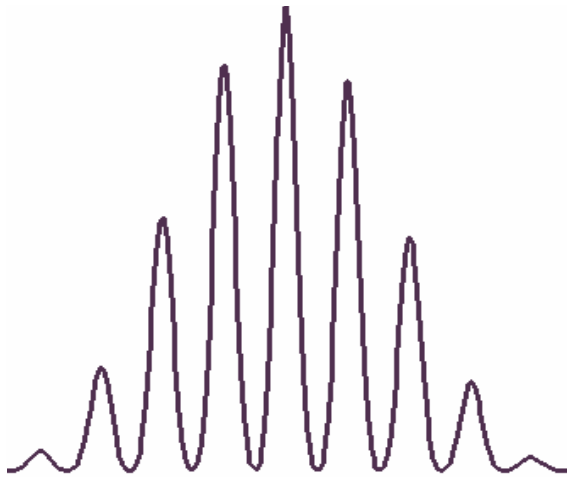
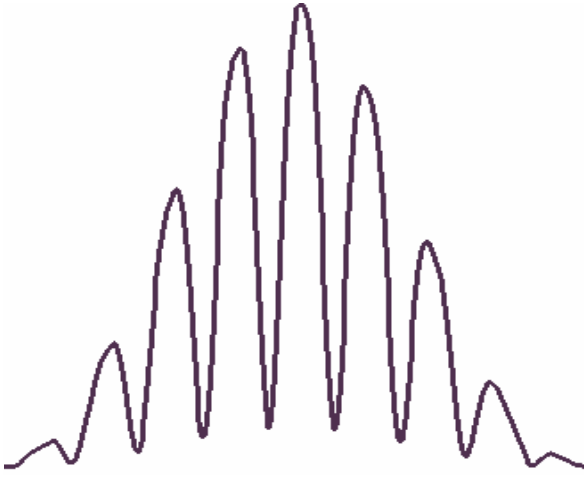
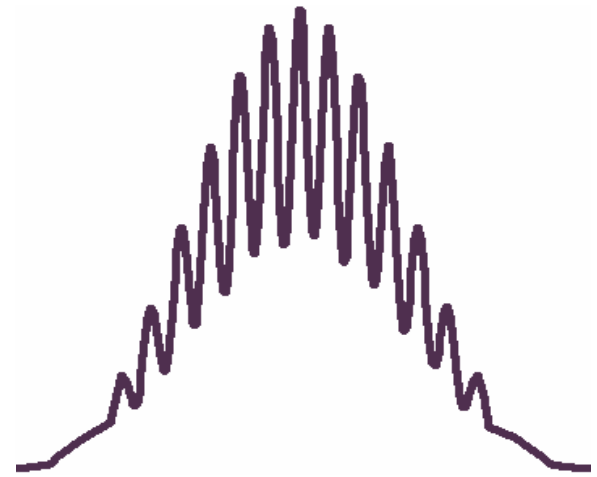
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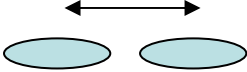


The fringe contrast (part I)

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| Small source ($\Phi_s \ll \lambda/B$) | Mid source ($\Phi_s \sim \lambda/B$) | Large source ($\Phi_s \sim \lambda/D$) |
|--|---|--|
|  |  |  |
|  |  |  |
| High contrast | Mid contrast | Low contrast |
| $V \sim 1$ | $V \sim 0.6$ | $V \sim 0.2$ |

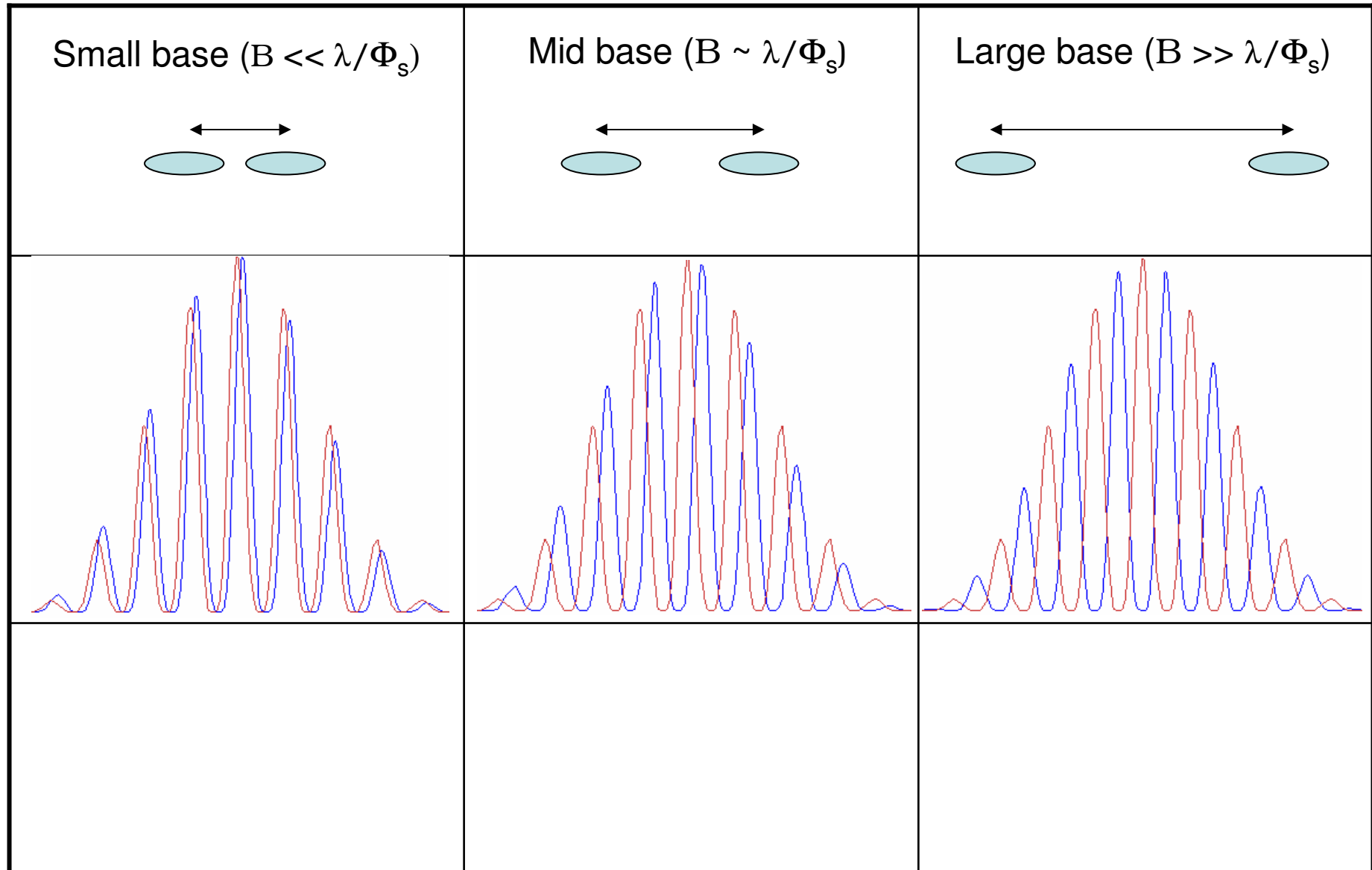
The fringe contrast (part II)

❑ For a given dimension of the source Φ_s and for different baseline lengths B

| Small base ($B \ll \lambda/\Phi_s$) | Mid base ($B \sim \lambda/\Phi_s$) | Large base ($B \gg \lambda/\Phi_s$) |
|---|--|---|
|  |  |  |
| | | |
| | | |

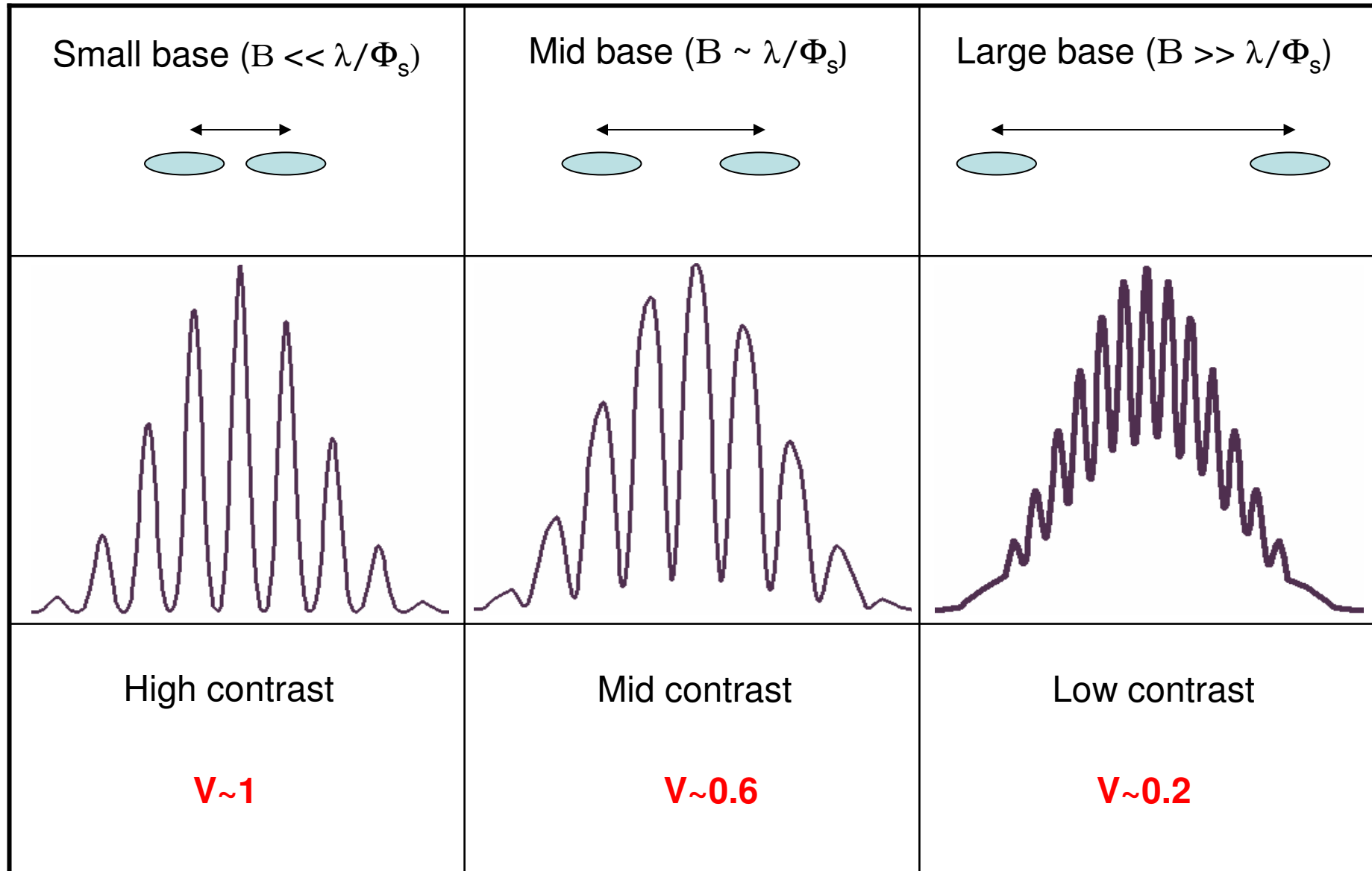
The fringe contrast (part II)

□ For a given dimension of the source Φ_s and for different baseline lengths B



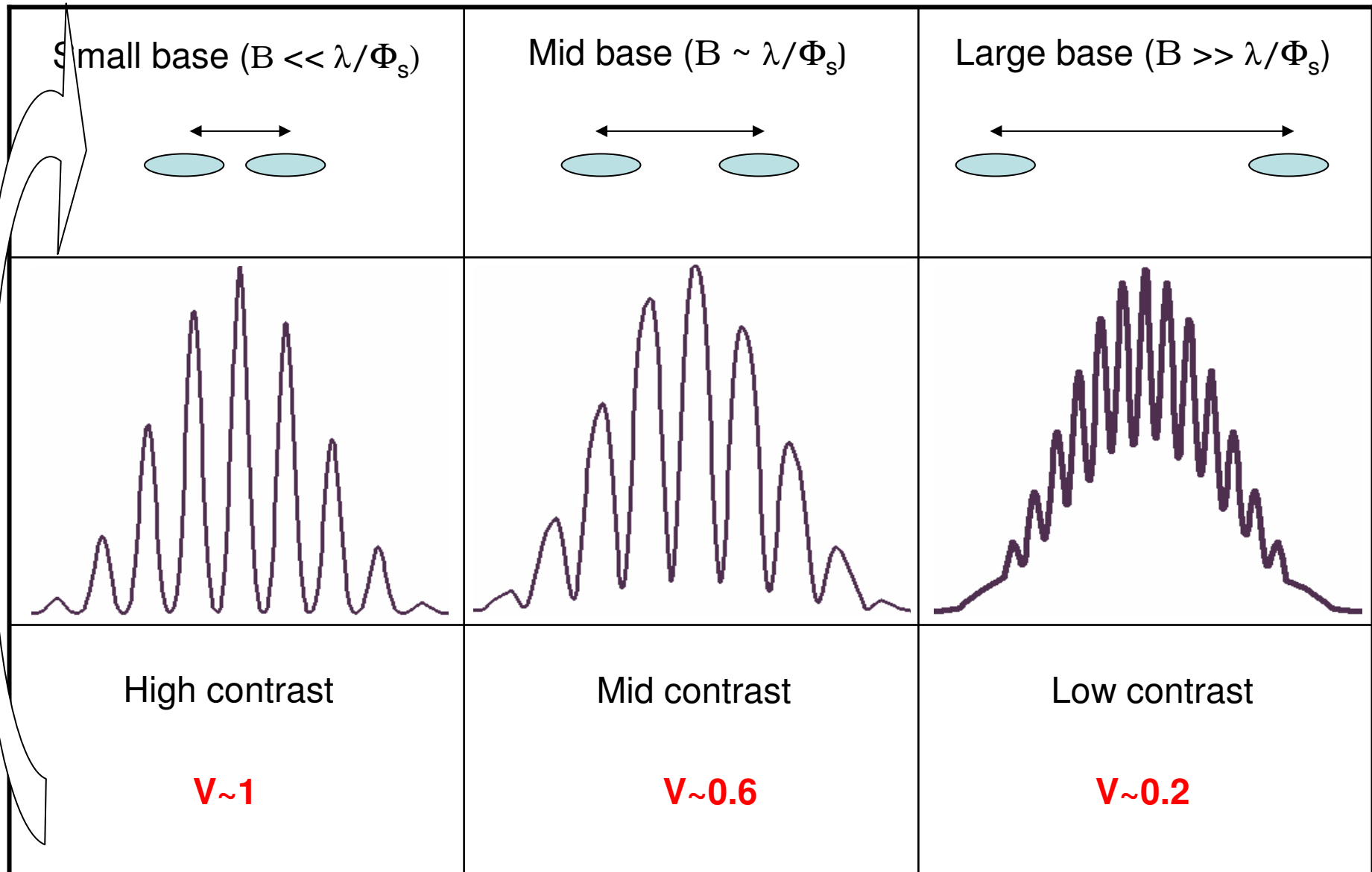
The fringe contrast (part II)

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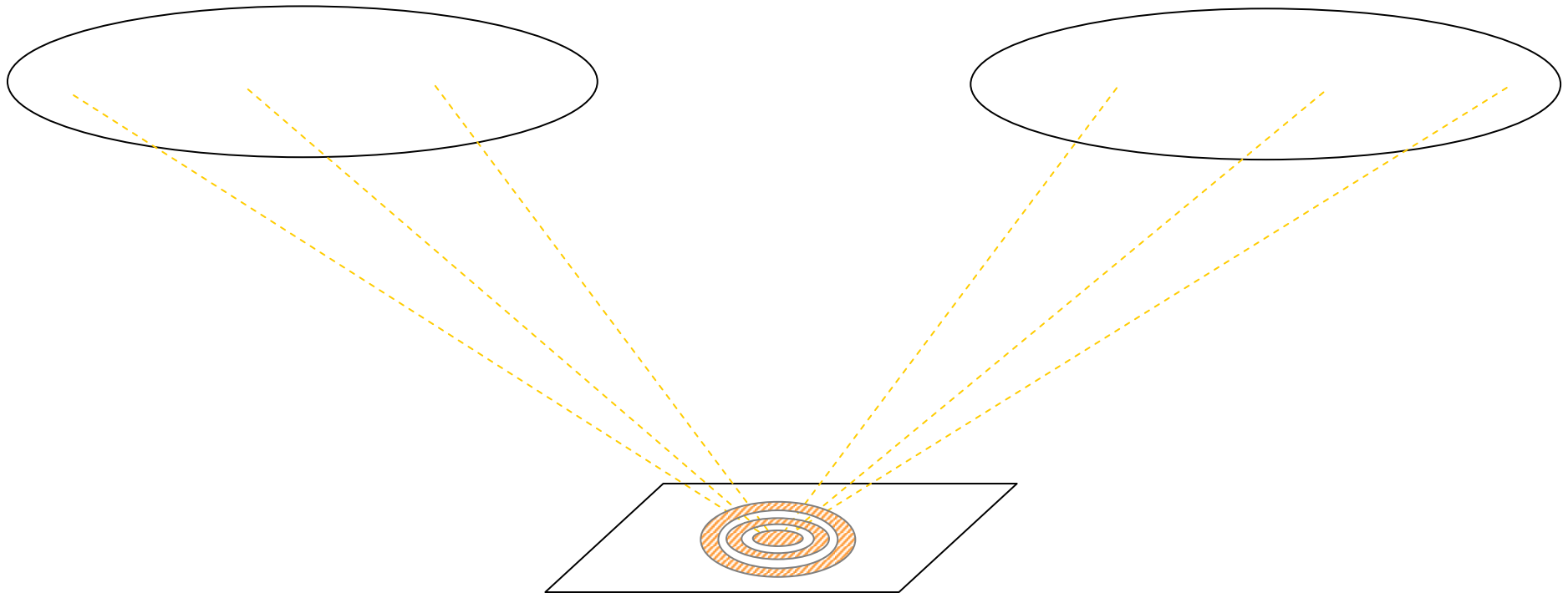
The fringe contrast (part II)

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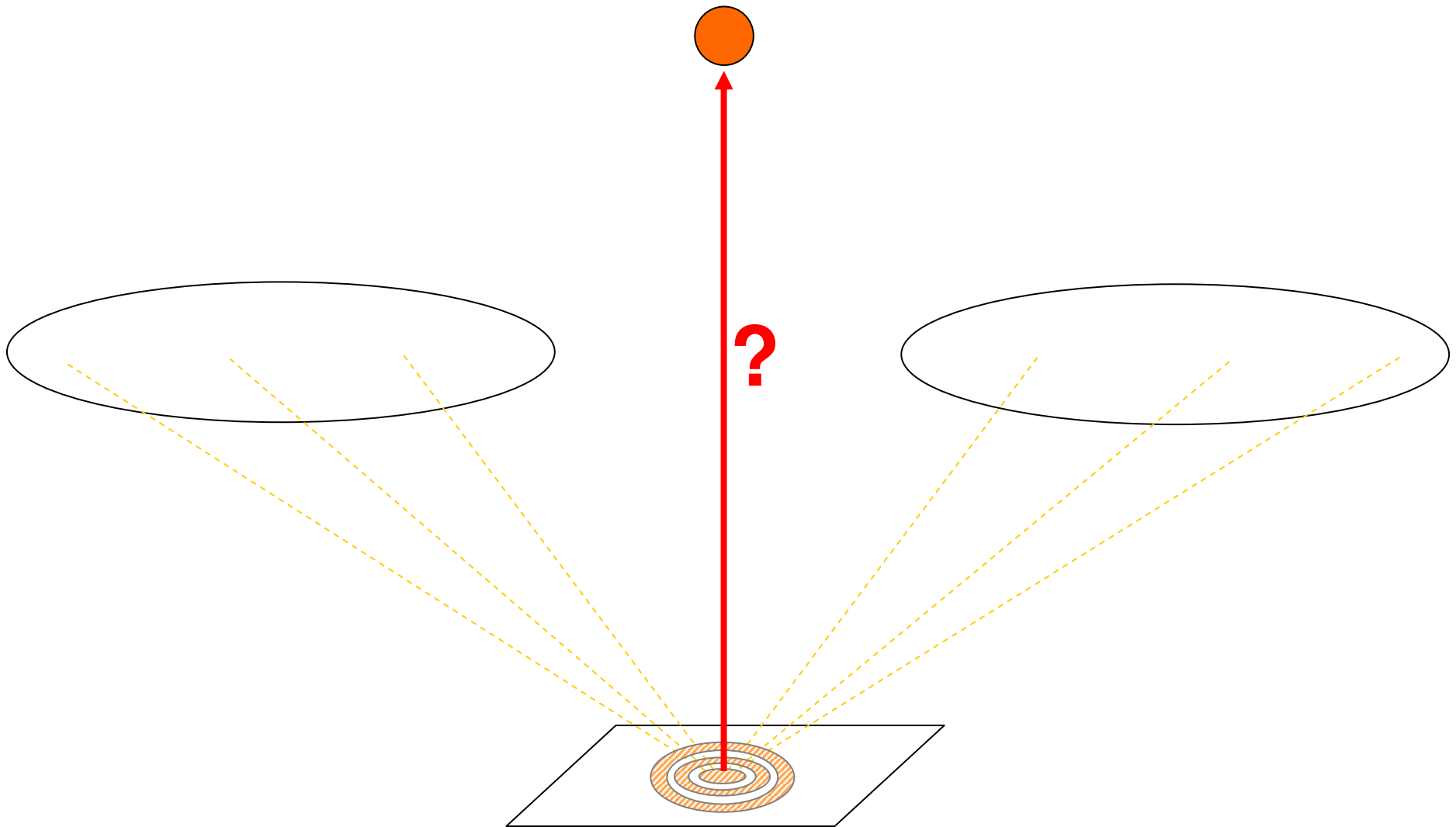
Object-Contrast Relation

The Van Cittert and Zernike theorem



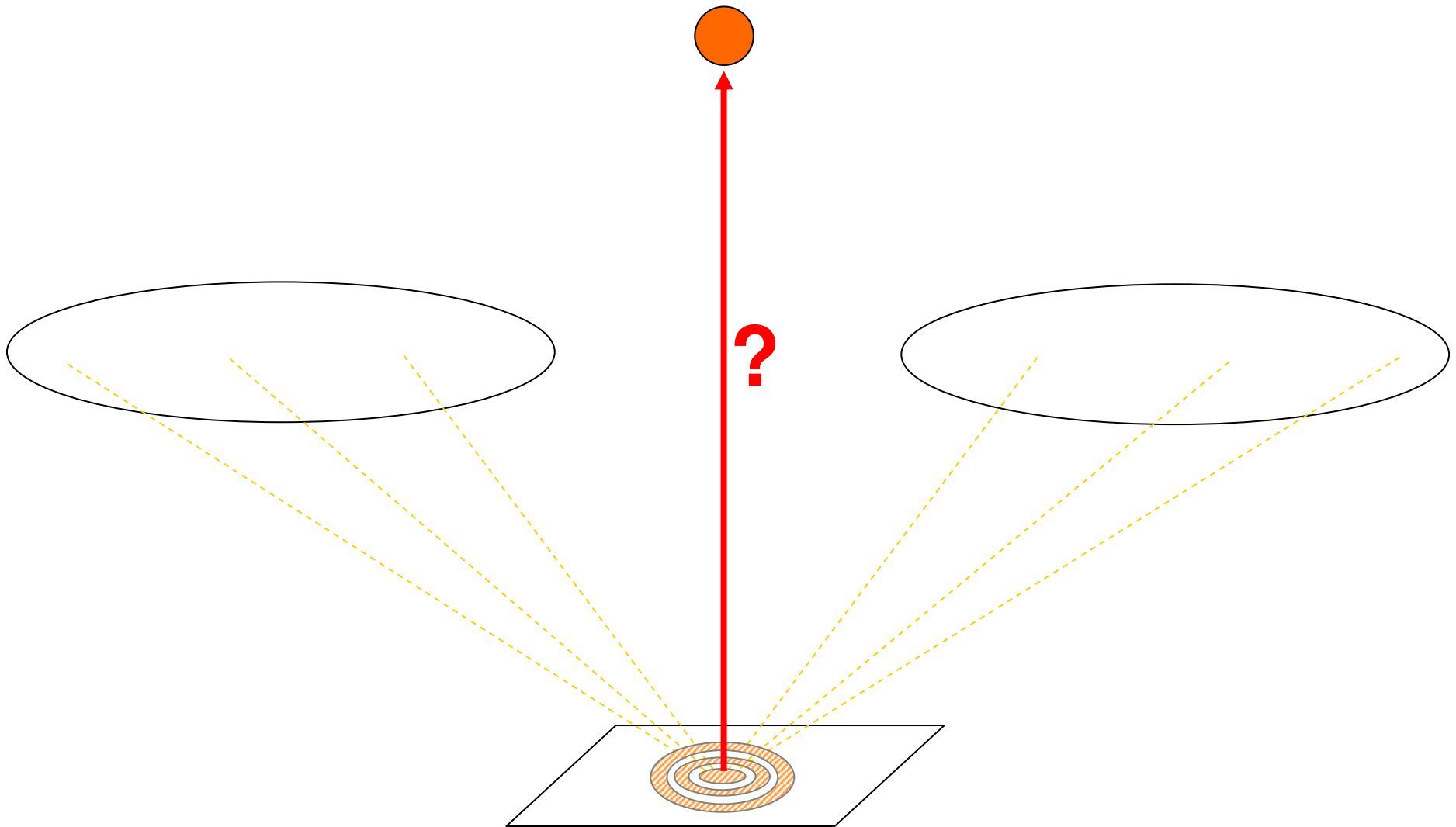
Object-Contrast Relation

The Van Cittert and Zernike theorem



Object-Contrast Relation

The Van Cittert and Zernike theorem



$$V = \left| \frac{\hat{O}(u,v)}{\hat{O}(0,0)} \right|$$

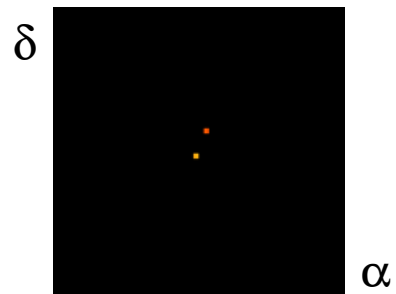
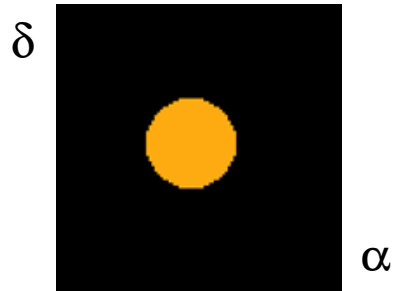
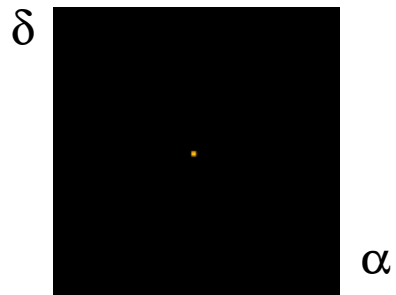
The Van Cittert and Zernike theorem

The fringe contrast of a source of emissivity \mathbf{O} is equal to the modulus of the Fourier Transform of \mathbf{O} at a given spatial frequency normalized by the FT of \mathbf{O} at the origin.

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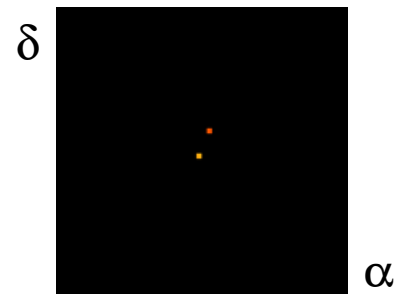
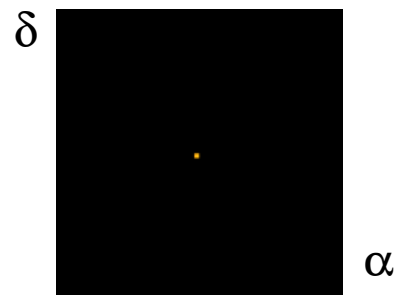
Direct Space $\mathbf{O}(\alpha, \delta)$



The Van Cittert and Zernike theorem

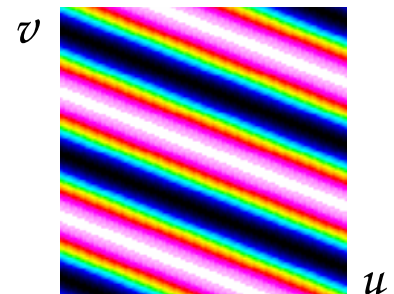
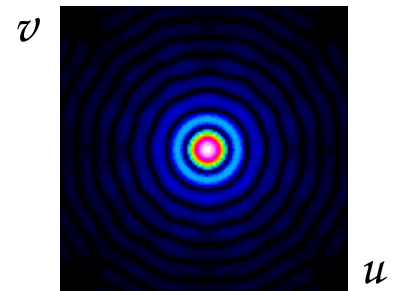
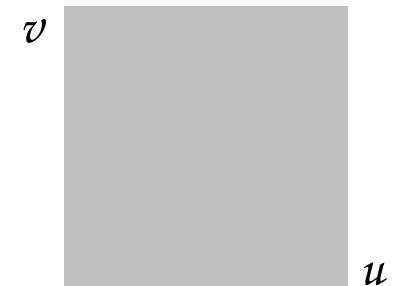
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Direct Space $\mathbf{O}(\alpha, \delta)$



Fourier space/ uv -plane/
spatial frequencies plane

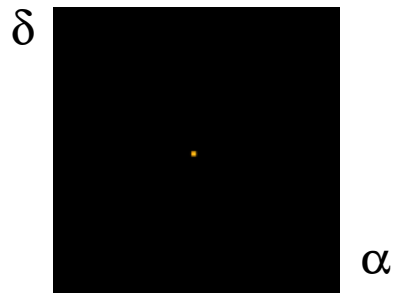
$$|\hat{\mathbf{O}}(u, v) / \hat{\mathbf{O}}(0, 0)|$$



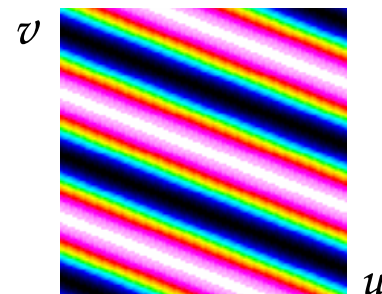
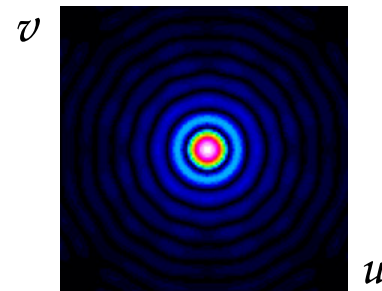
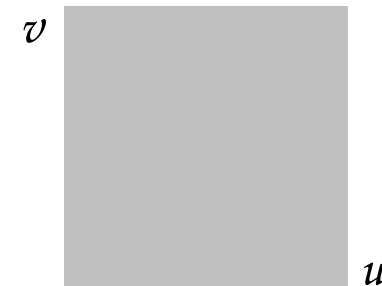
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Fourier space/ uv -plane/
spatial frequencies plane
 $|\hat{\mathbf{O}}(u, v) / \hat{\mathbf{O}}(0, 0)|$



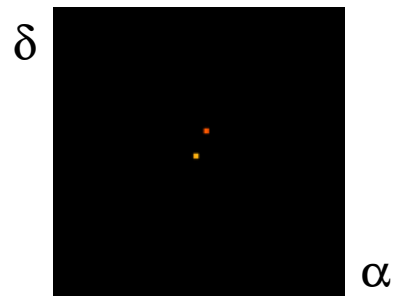
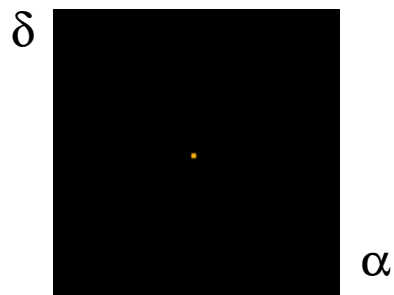
$$\left| \frac{\iint \mathbf{O}(\alpha, \delta) \cdot \exp[-i \cdot 2\pi (u\alpha + v\delta)] \cdot d\alpha d\delta}{\iint \mathbf{O}(\alpha, \delta) \cdot d\alpha d\delta} \right|$$

Does someone recognize
this denominator?

The Van Cittert and Zernike theorem

The fringe contrast of a source of emissivity \mathbf{O} is equal to the modulus of the Fourier Transform of \mathbf{O} at a given spatial frequency normalized by the FT of \mathbf{O} at the origin.

Direct Space $\mathbf{O}(\alpha, \delta)$

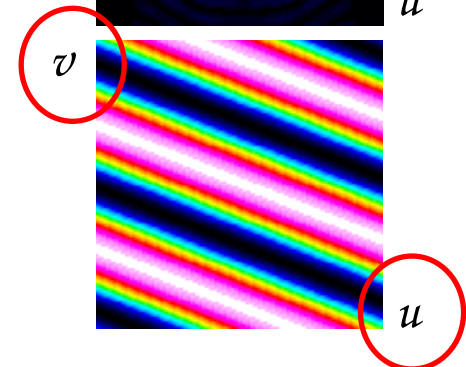
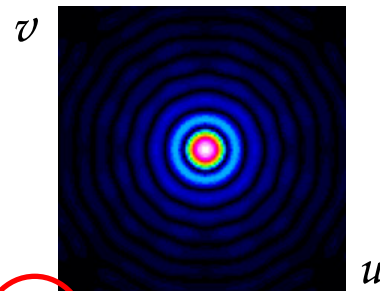
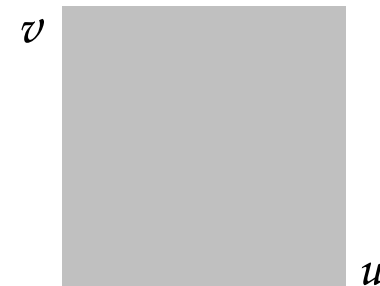


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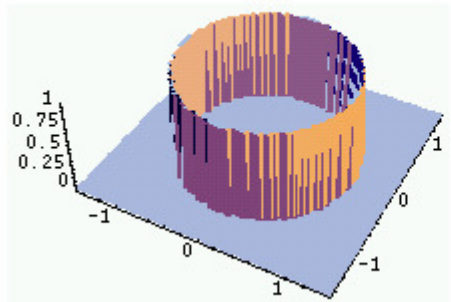
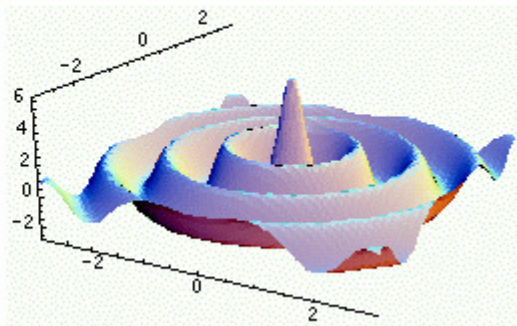
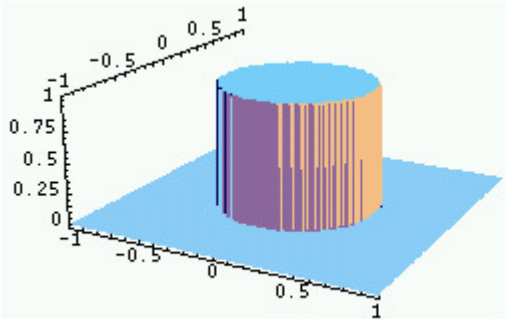
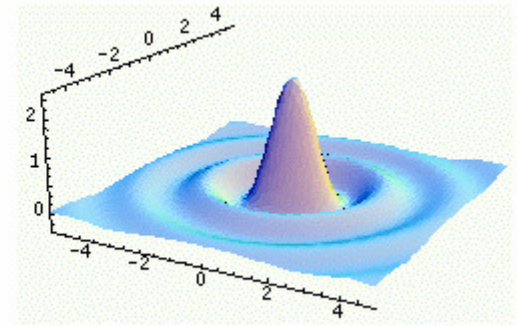
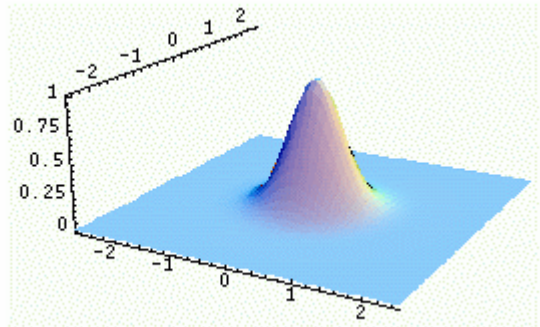
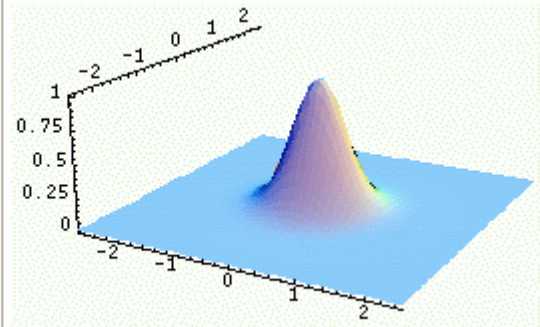
\swarrow
 Does someone recognize this denominator?

Fourier space/uv-plane/
spatial frequencies plane

$|\hat{\mathbf{O}}(u, v) / \hat{\mathbf{O}}(0, 0)|$



Some Fourier (Hankel) transformations

| Fonction | Graphe de la fonction | Transformée | Graphe de la TF |
|-------------------------------|---|--|--|
| $\delta(r - a)$ |  | $2\pi a J_0(2\pi a q)$ |  |
| $\Pi\left(\frac{r}{d}\right)$ |  | $2 \left(\frac{\pi d^2}{4} \right) J_{1c}(\pi d q)$ |  |
| $\exp(-\pi r^2)$ |  | $\exp(-\pi q^2)$ |  |

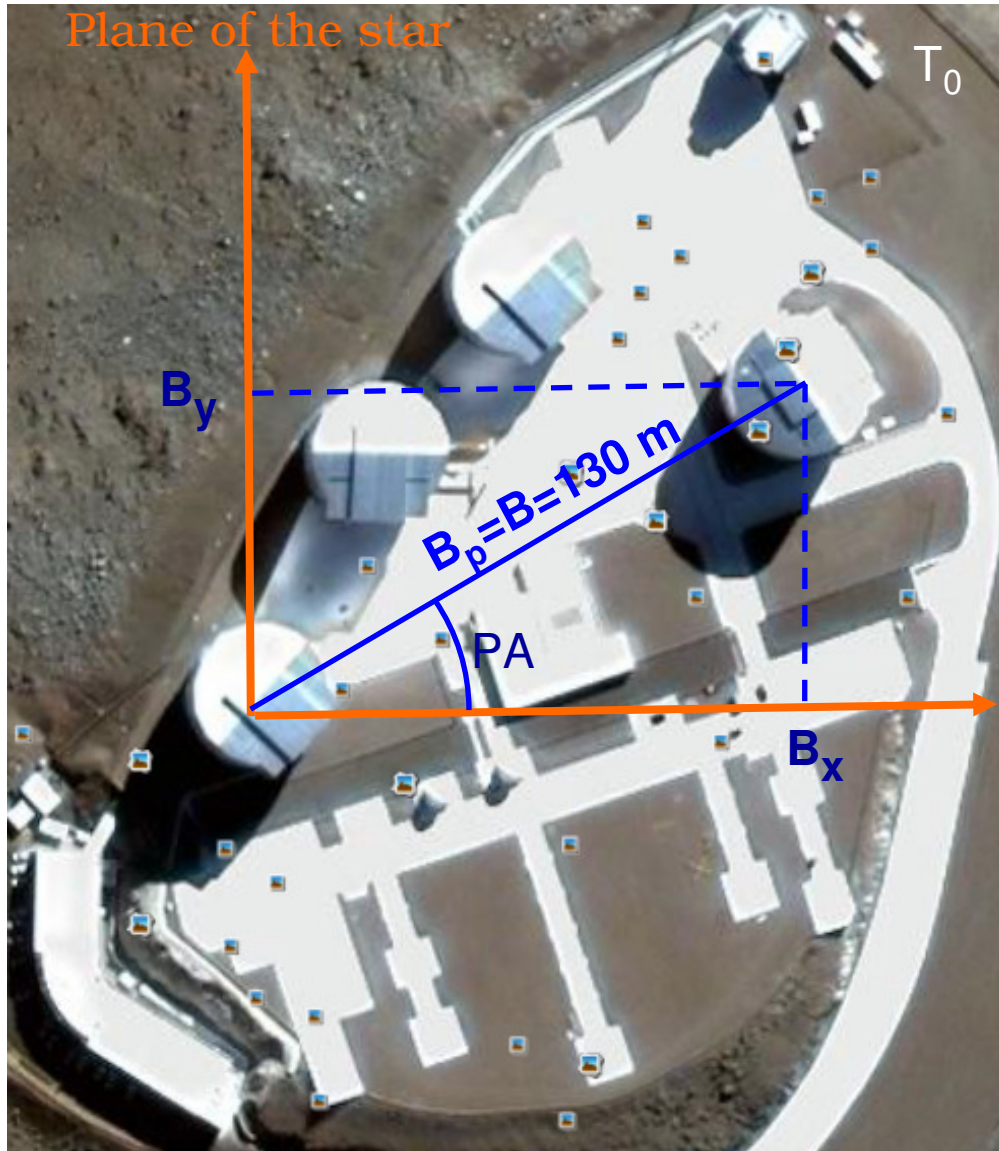
(*) $r = (\alpha^2 + \delta^2)^{1/2}$

(*) $q = (u^2 + v^2)^{1/2} = B_p/\lambda$

(**) $J_{1c}(X) = J_1(X)/X$

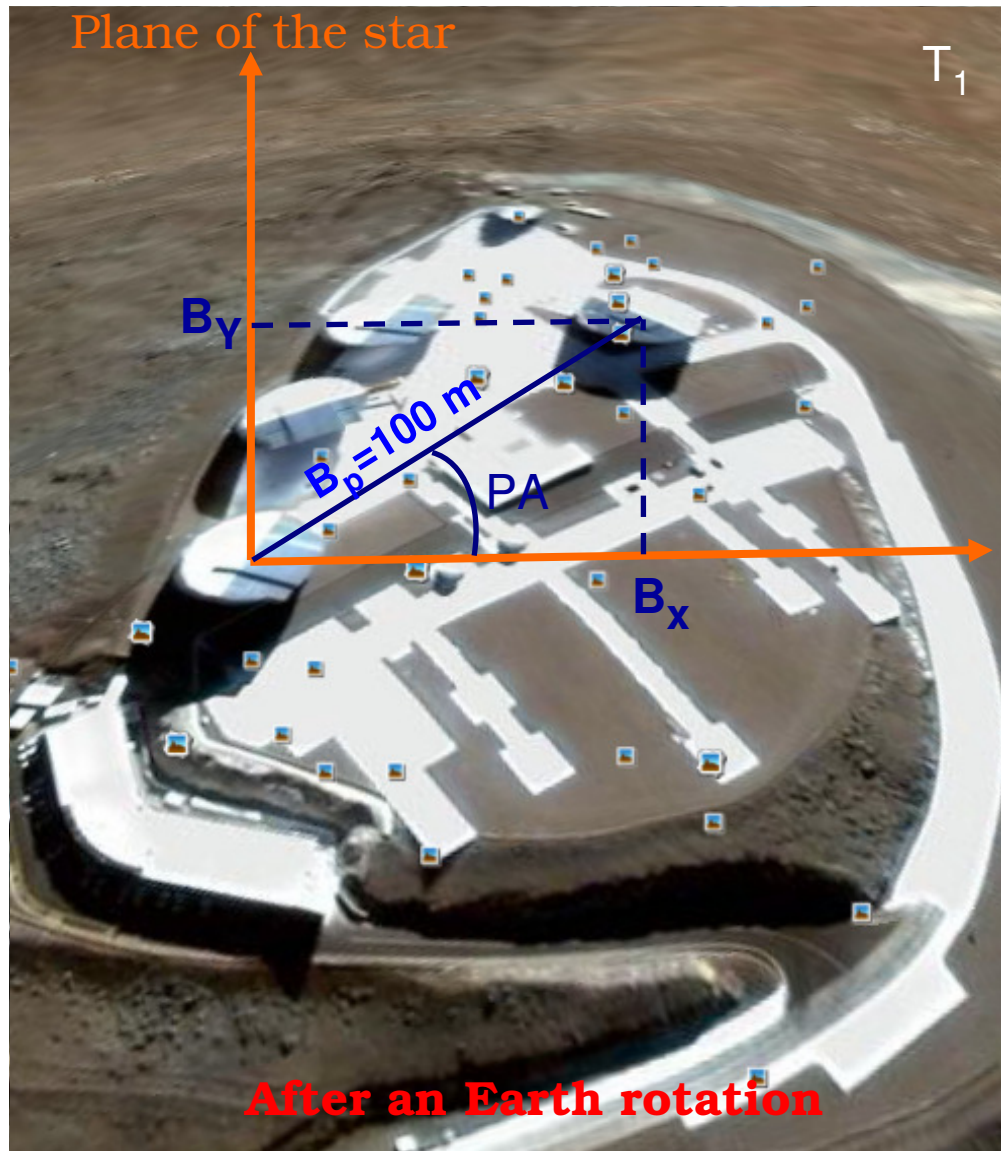
The uv-plane (part I)

spatial frequencies (u, v) : coordinates (B_x, B_y) of the projected baselines (B_p) seen from the star and divided by the observing wavelength (λ)



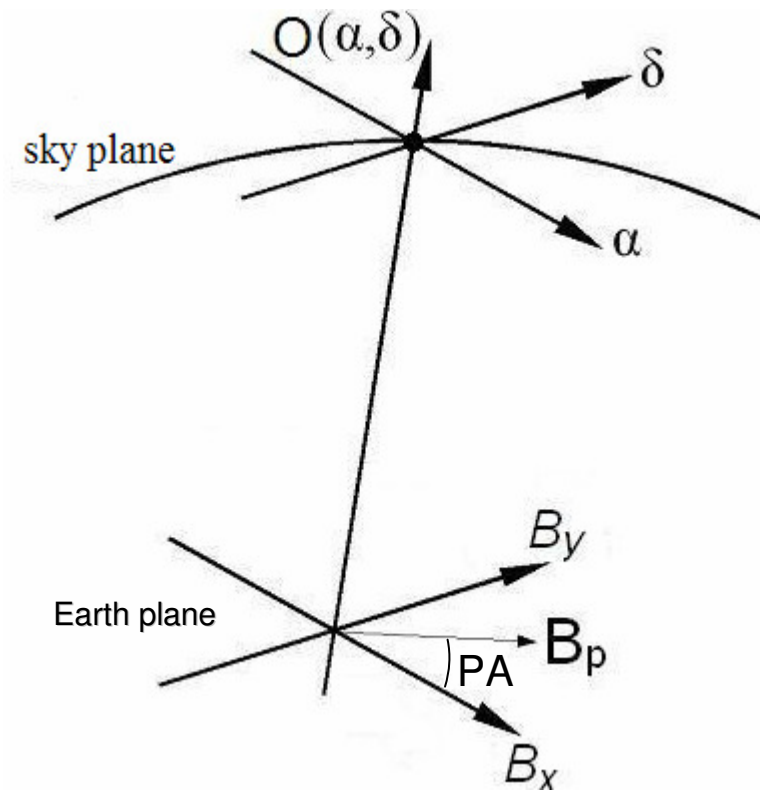
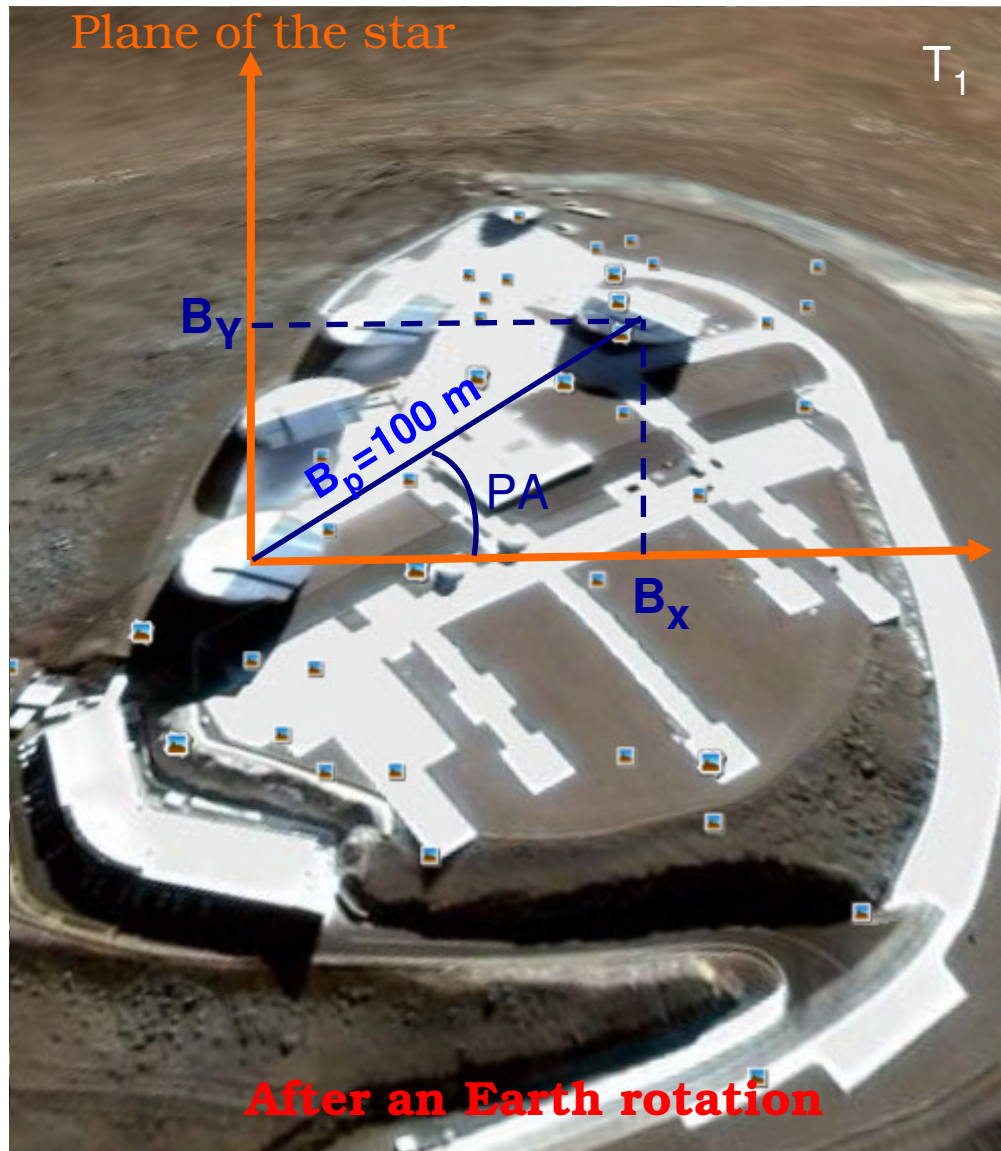
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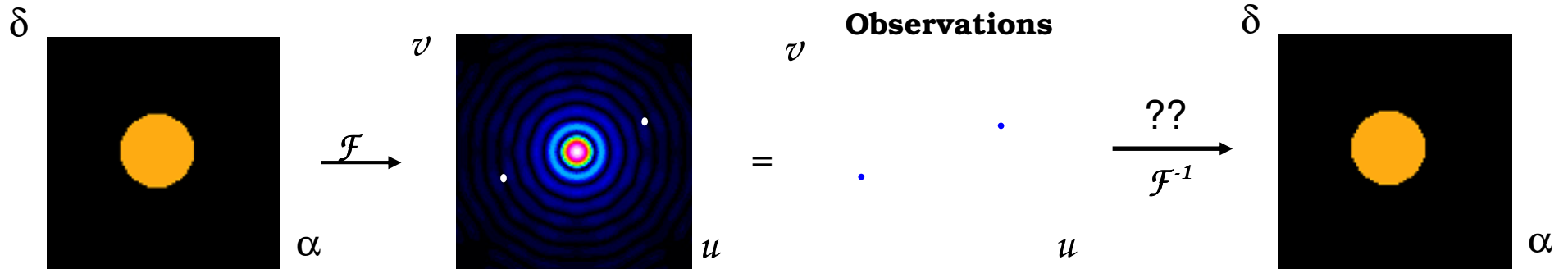
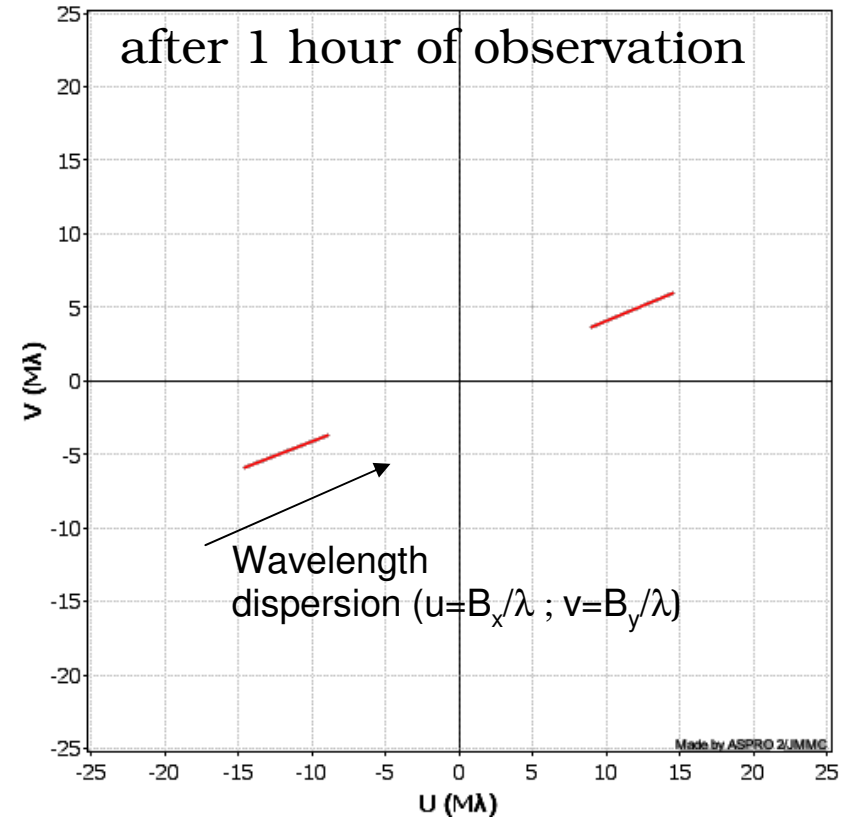
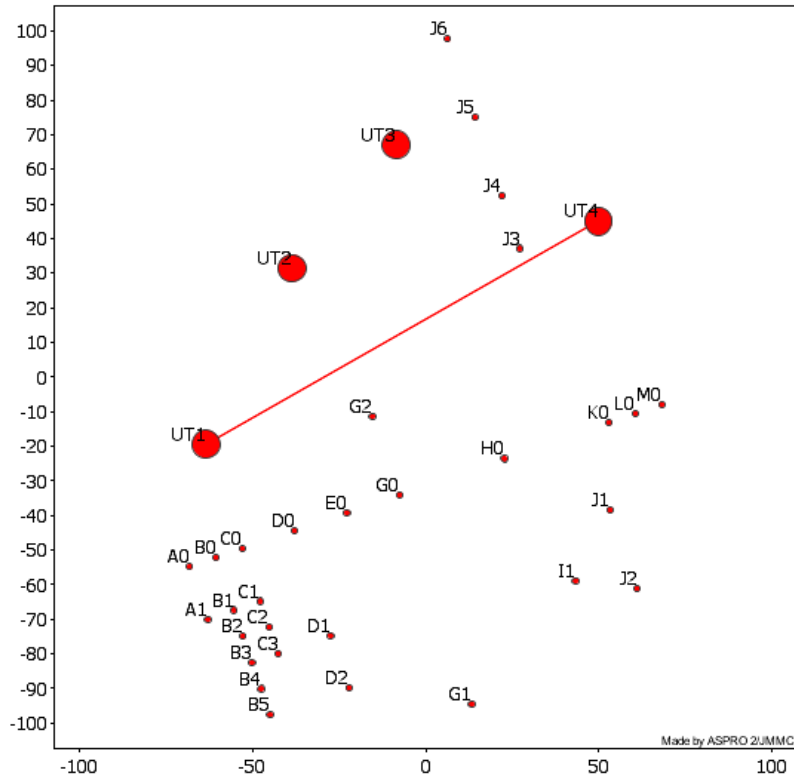


$$\begin{cases} u = B_x / \lambda = B_p \cdot \cos(PA) / \lambda \\ v = B_y / \lambda = B_p \cdot \sin(PA) / \lambda \end{cases}$$

$$B_p / \lambda = \sqrt{u^2 + v^2}$$

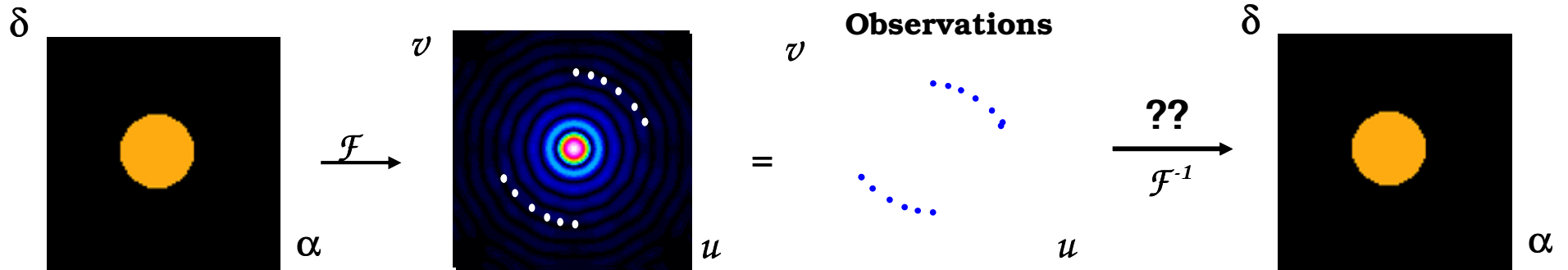
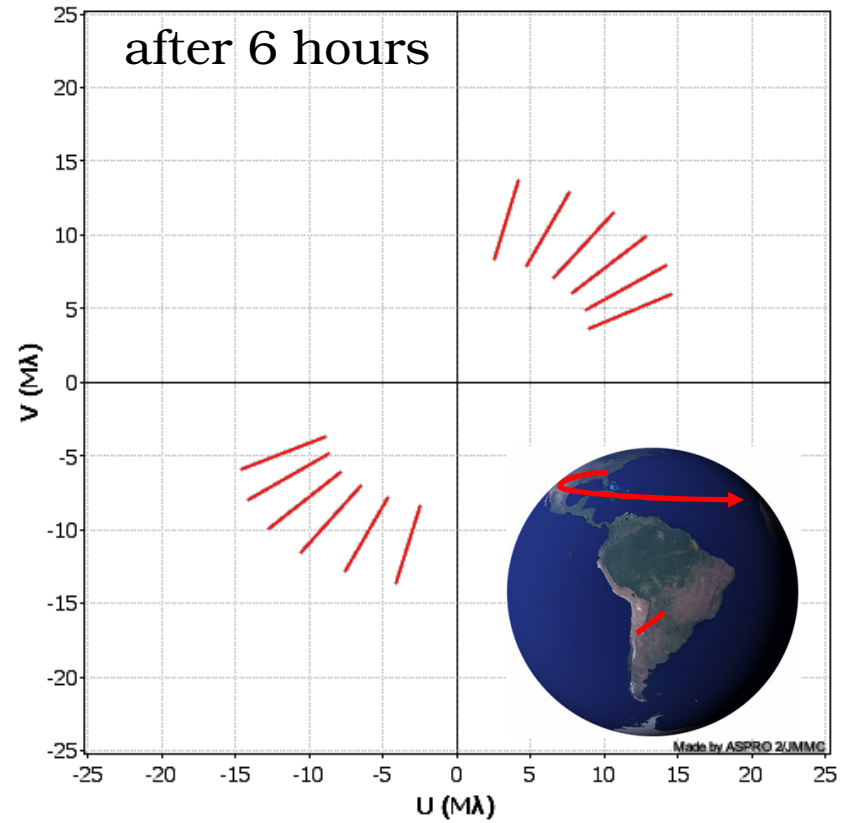
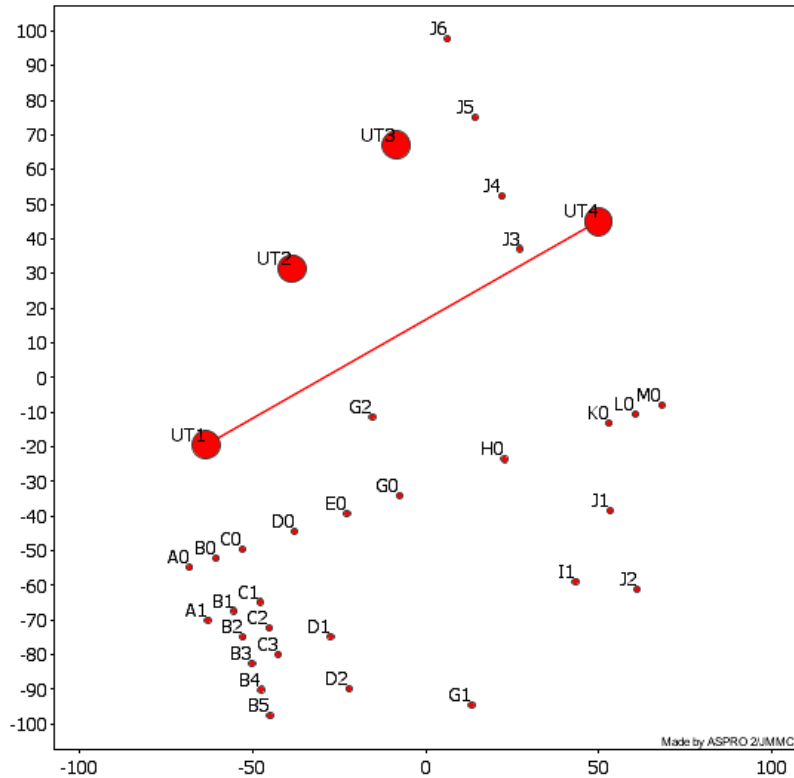
The uv-plane (part II)

Observation of R Scl ($\alpha=01:26:58$; $\delta=-32:32:35$) at the date of 19 August 2011



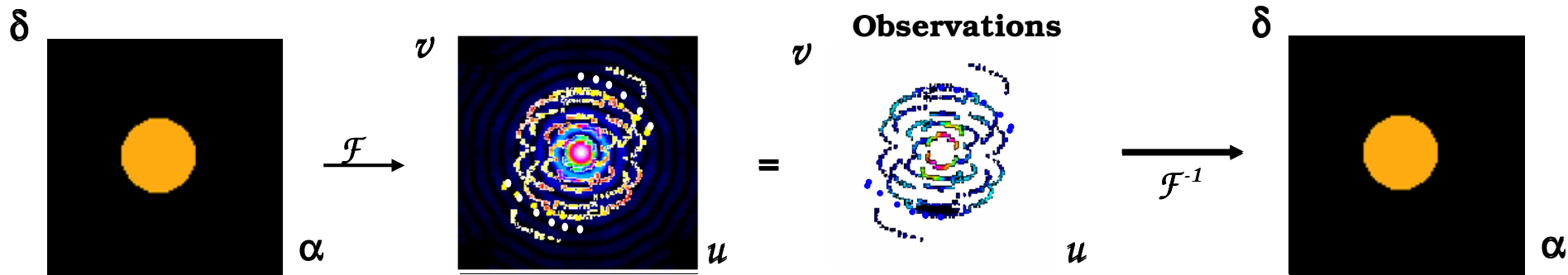
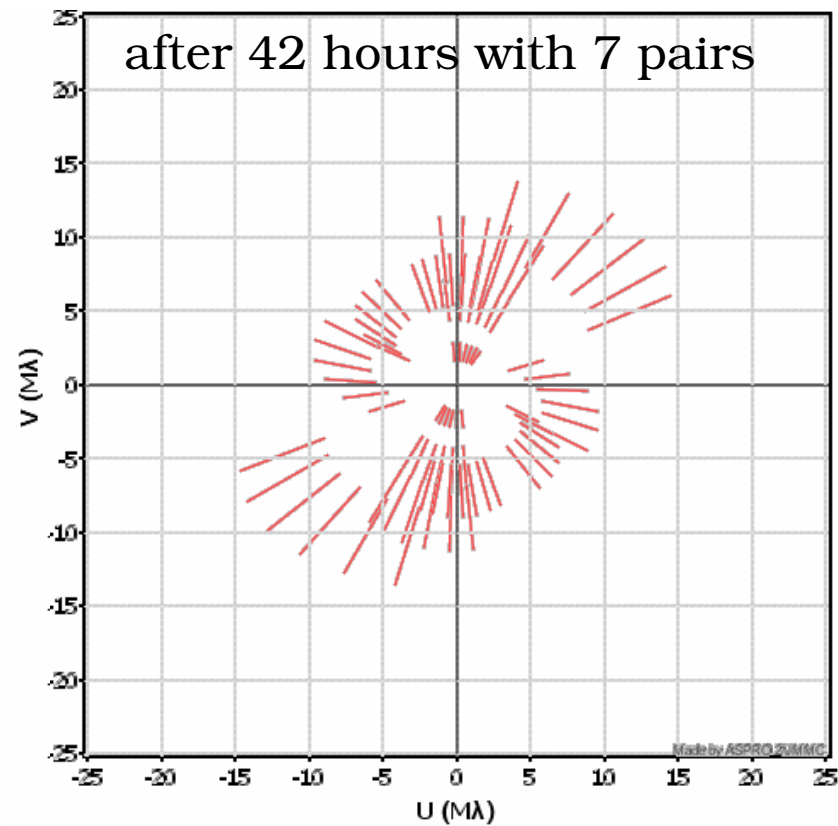
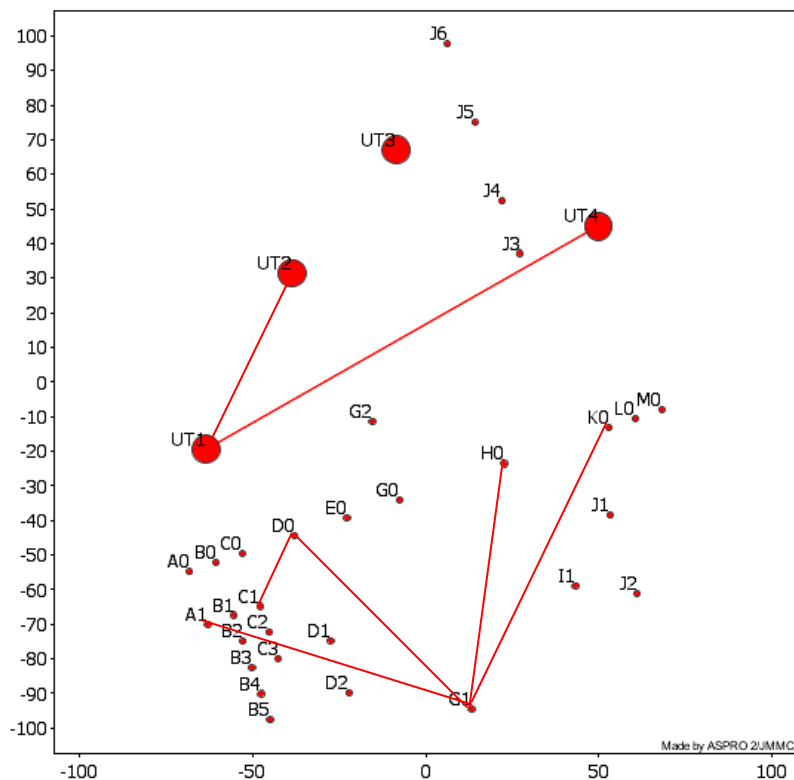
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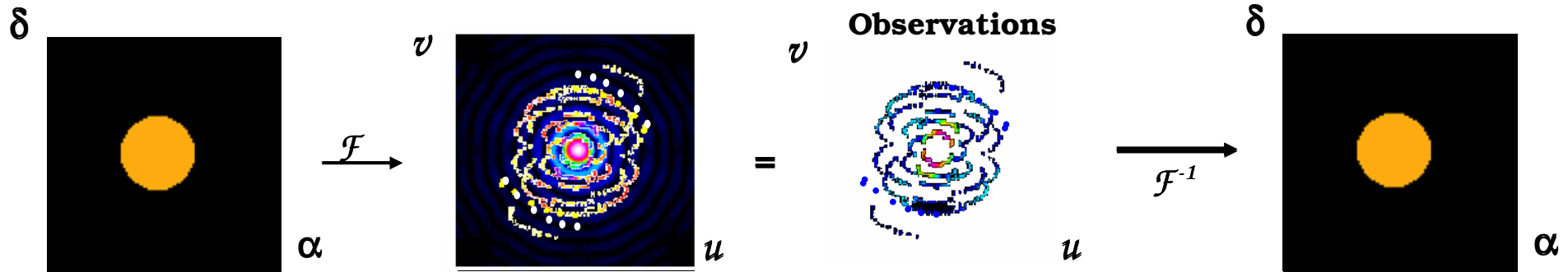
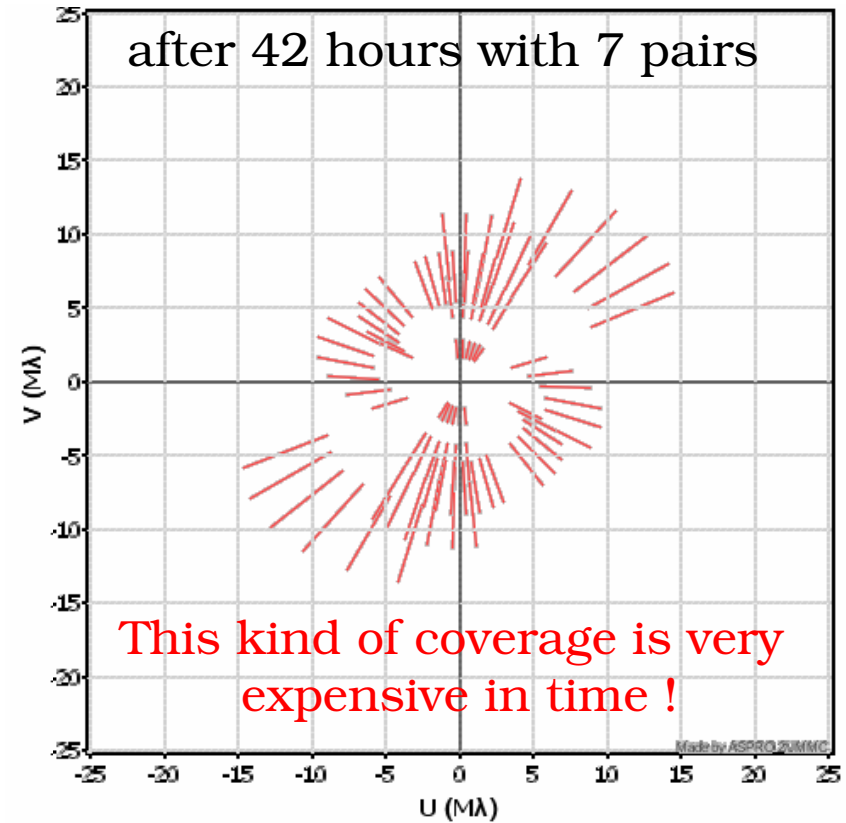
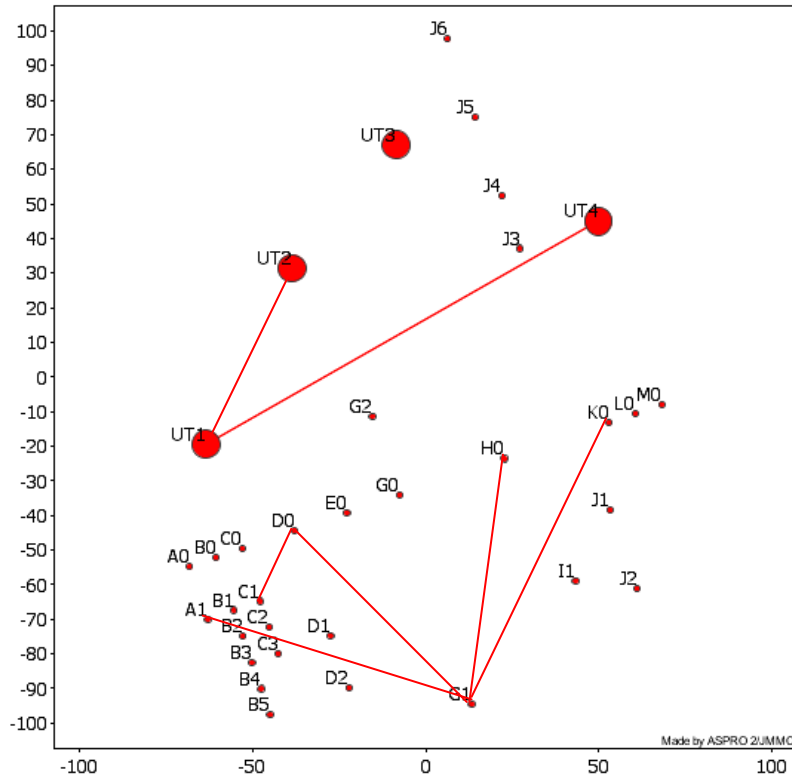
The uv-plane (part II)

Observation of R Scl ($\alpha=01:26:58$; $\delta=-32:32:35$) at the date of 19 August 2011



The uv-plane (part II)

Observation of R Scl ($\alpha=01:26:58$; $\delta=-32:32:35$) at the date of 19 August 2011



What is the appropriate uv coverage?

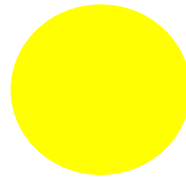
What is the appropriate uv coverage?

It depends on the complexity of the object

What is the appropriate *uv* coverage?

It depends on the complexity of the object

Is it really necessary to get a very large uv-coverage for such an object?

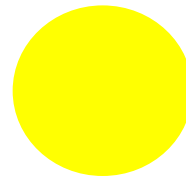


[hot star]

What is the appropriate *uv* coverage?

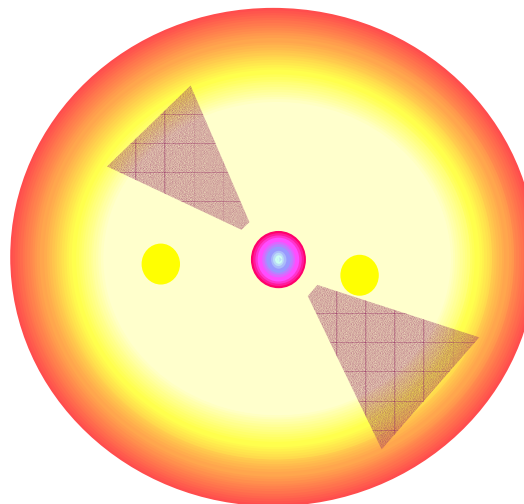
It depends on the complexity of the object

Is it really necessary to get a very large uv-coverage for such an object?



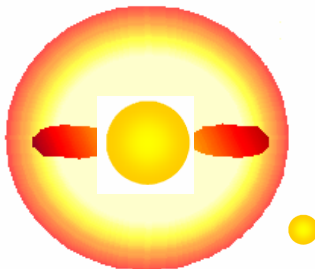
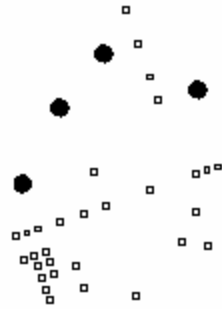
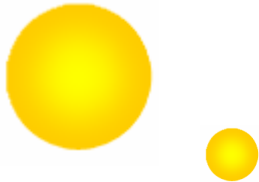
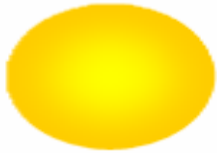
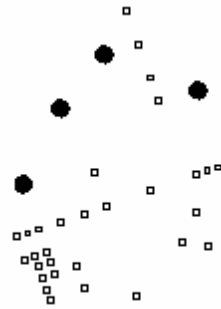
[hot star]

Is it necessary to get a very large uv-coverage for this one?

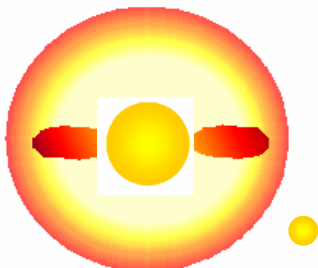
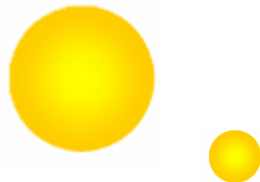
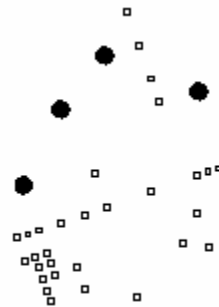
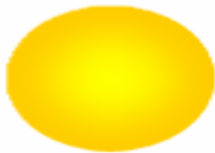
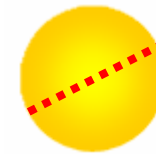
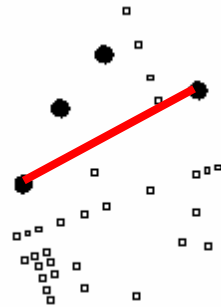


[Post-AGB (triple system +
envelope + disk)]

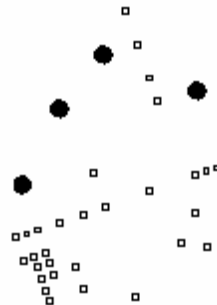
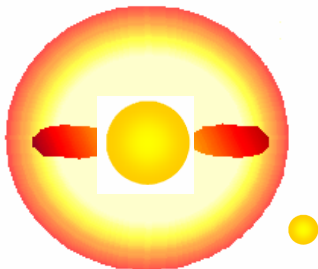
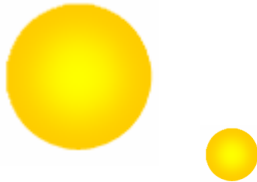
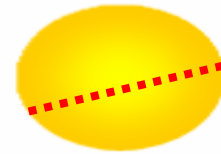
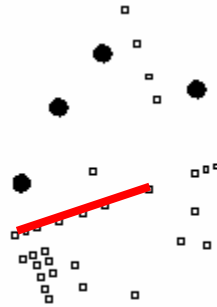
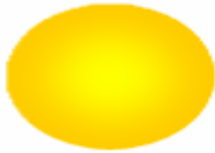
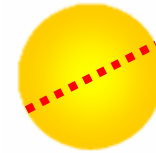
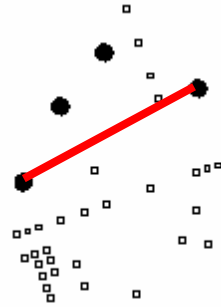
❖ Spatial information



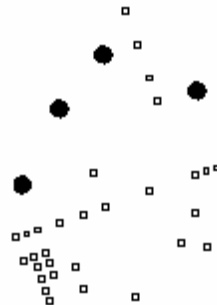
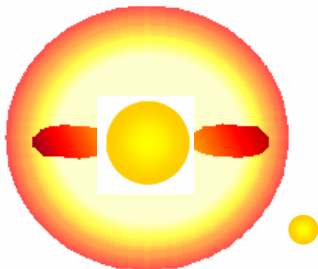
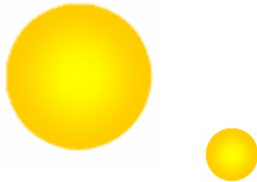
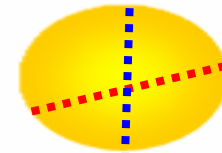
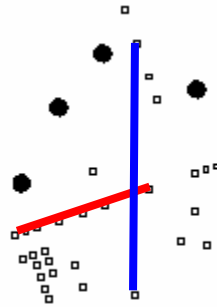
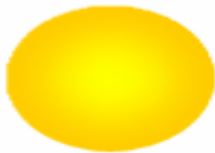
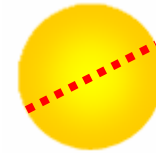
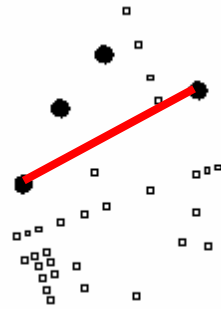
❖ Spatial information



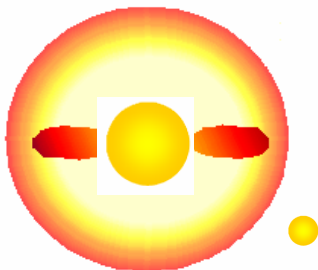
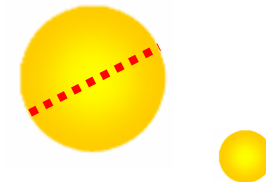
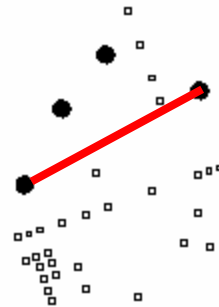
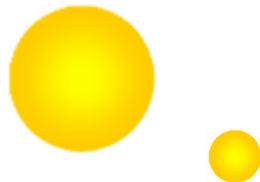
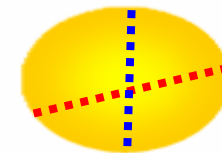
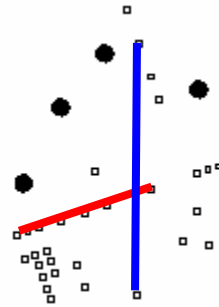
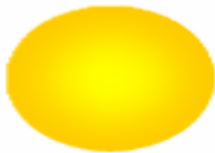
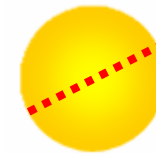
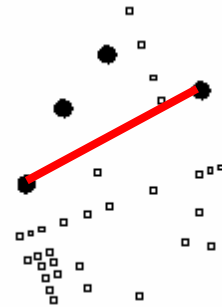
❖ Spatial information



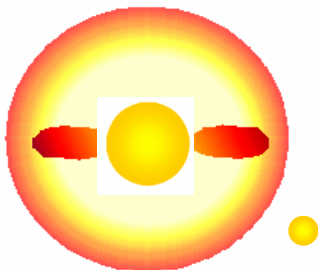
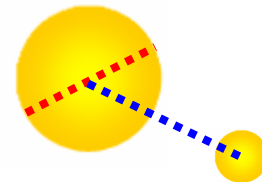
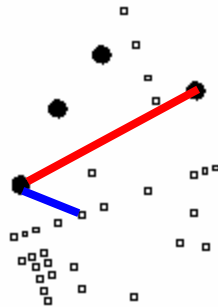
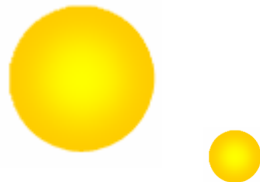
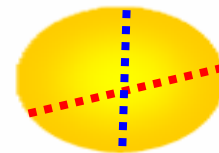
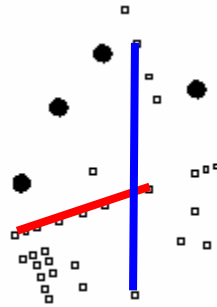
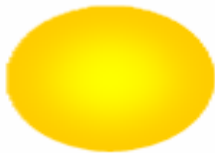
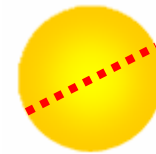
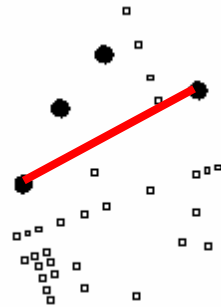
❖ Spatial information



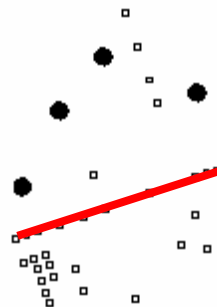
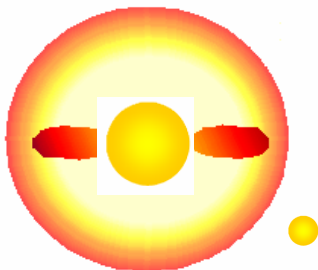
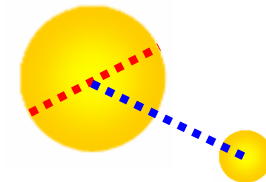
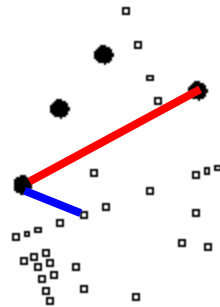
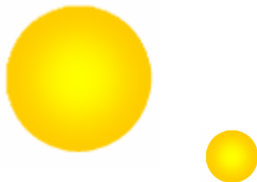
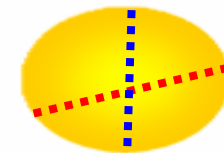
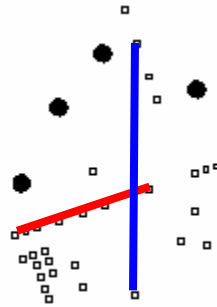
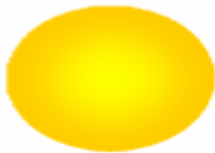
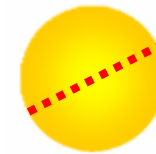
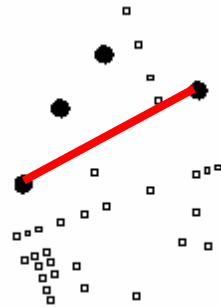
❖ Spatial information



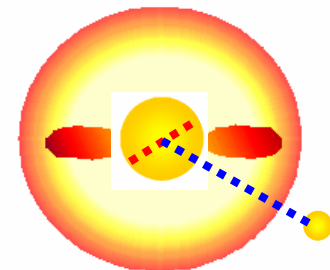
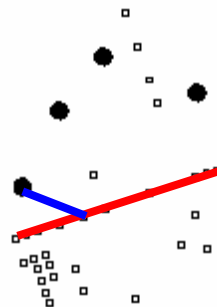
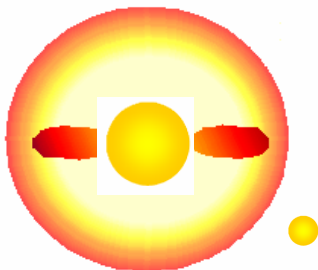
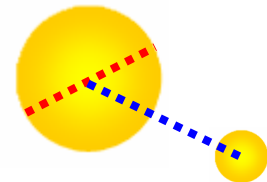
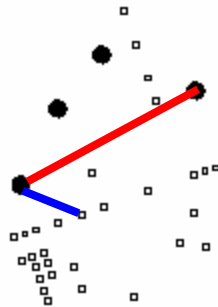
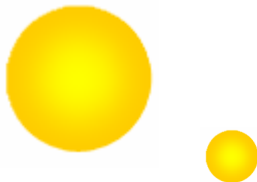
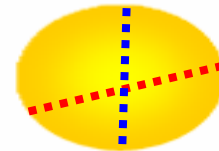
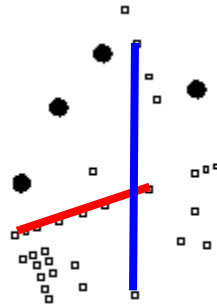
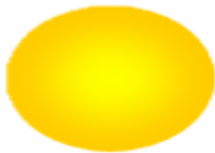
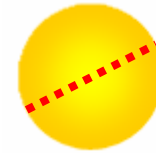
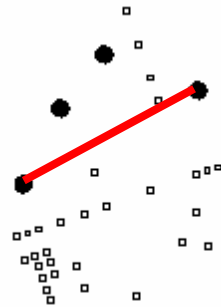
❖ Spatial information



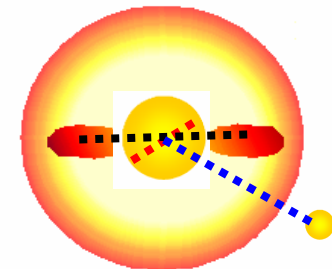
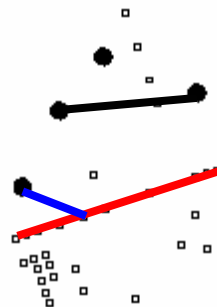
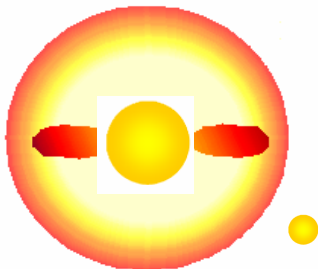
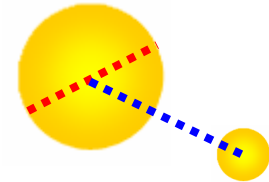
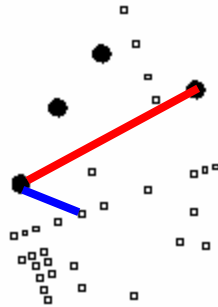
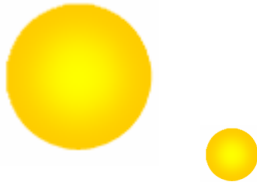
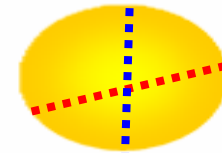
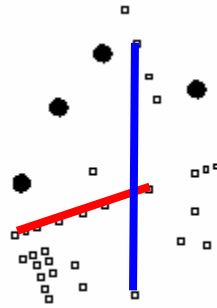
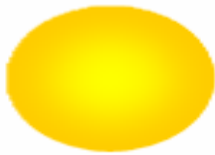
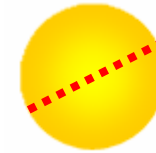
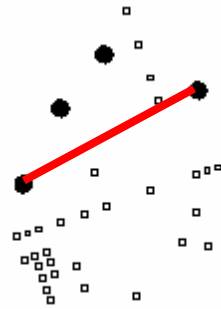
❖ Spatial information



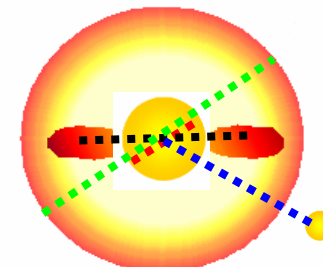
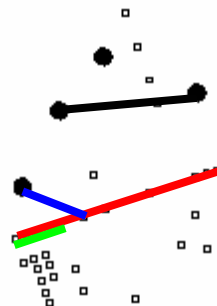
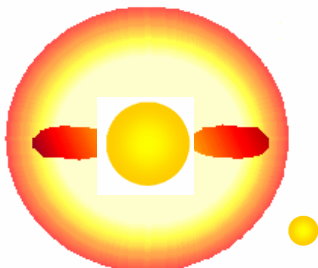
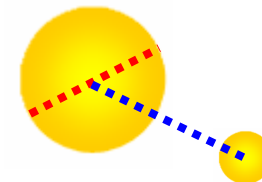
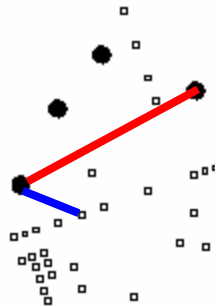
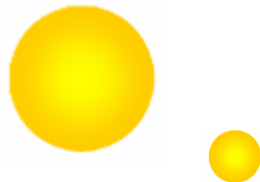
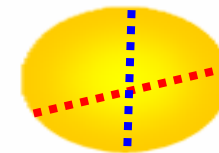
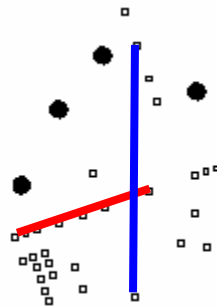
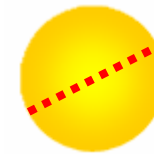
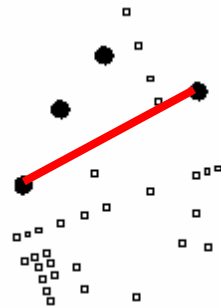
❖ Spatial information



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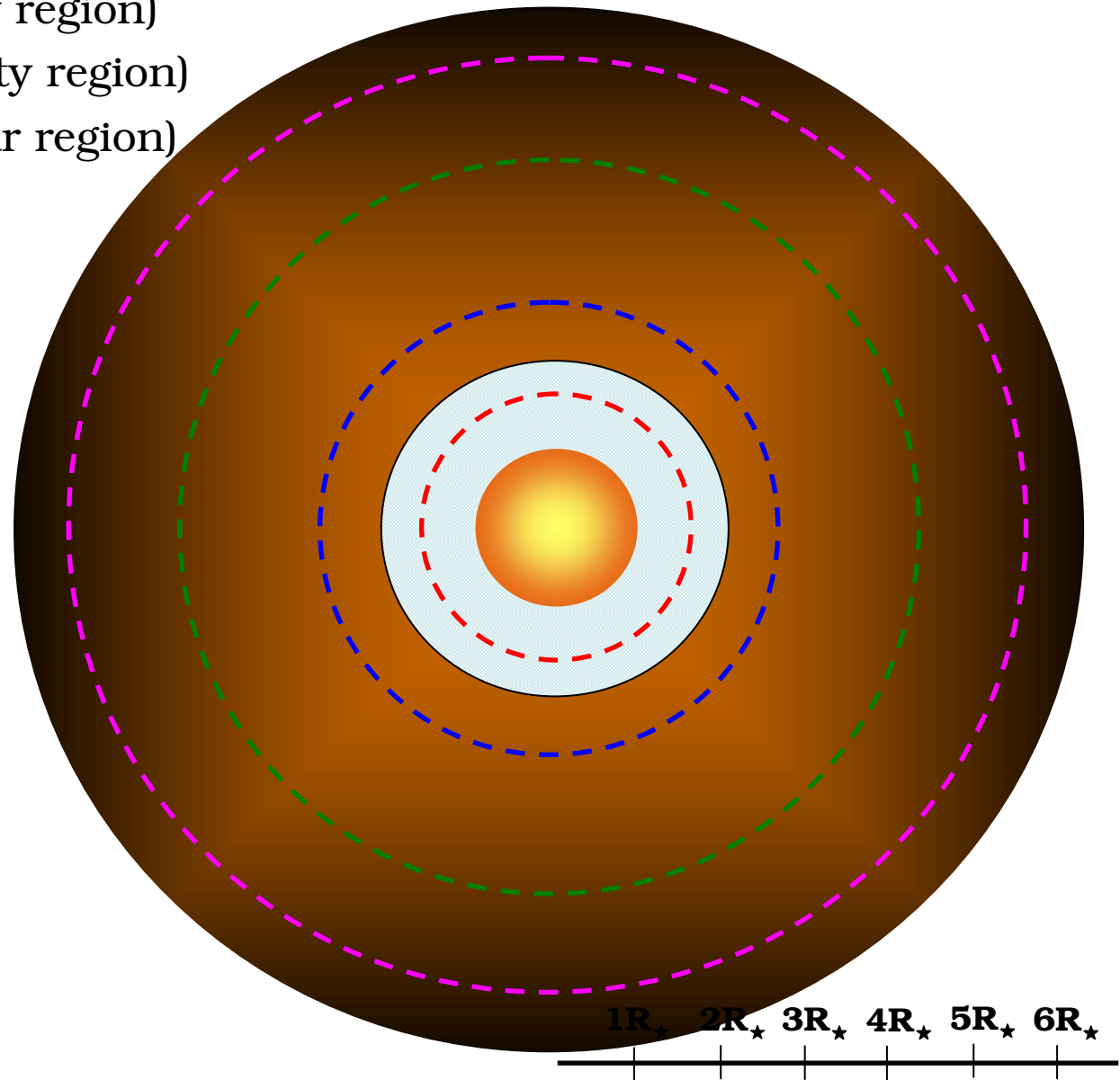


❖ Spatial information



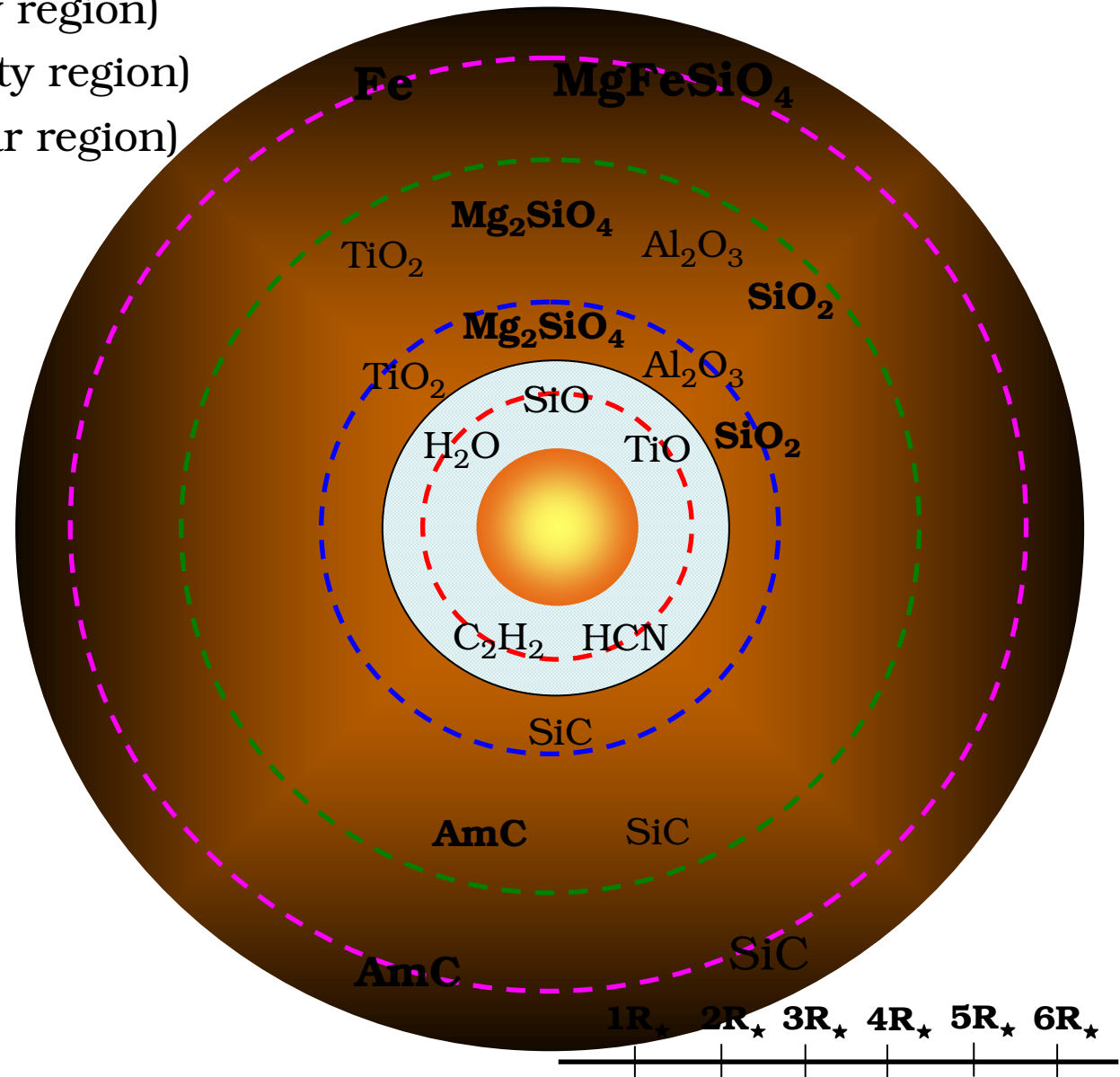
❖ Spectral information

- B=30m (outer dusty region)
- B=60m (mid dusty region)
- B=90m (inner dusty region)
- B=120m (molecular region)

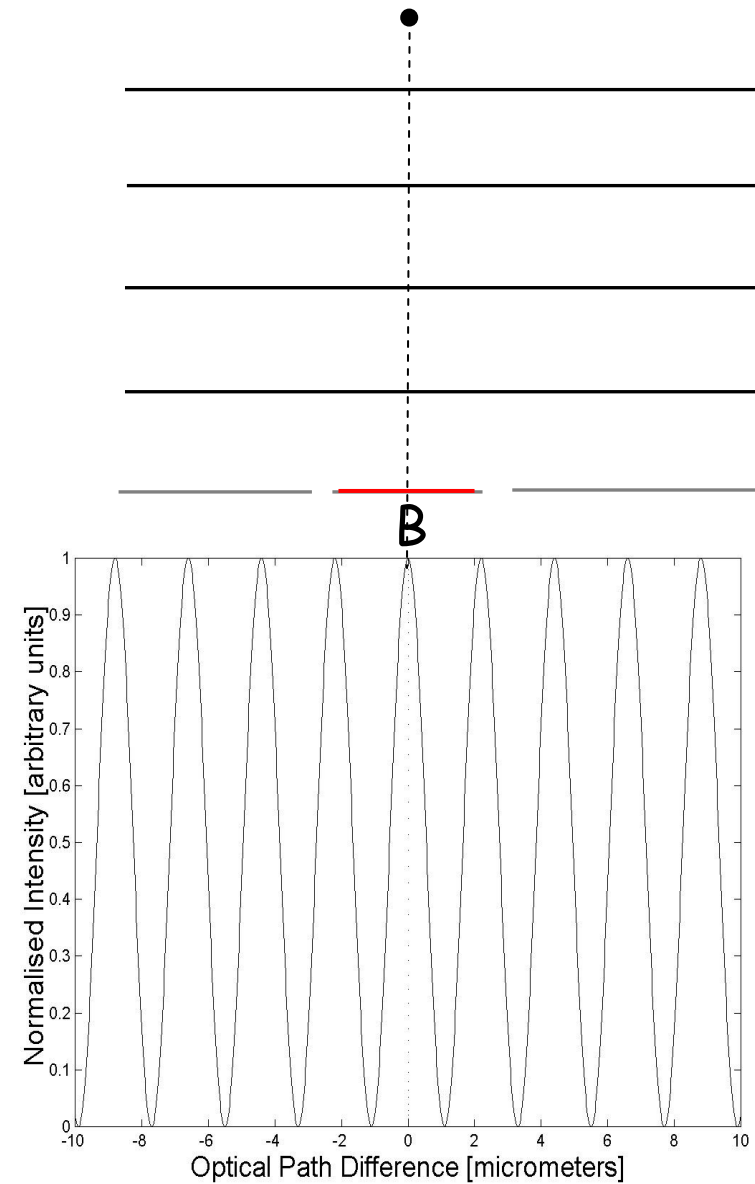


❖ Spectral information

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- B=90m (inner dusty region)
- B=120m (molecular region)



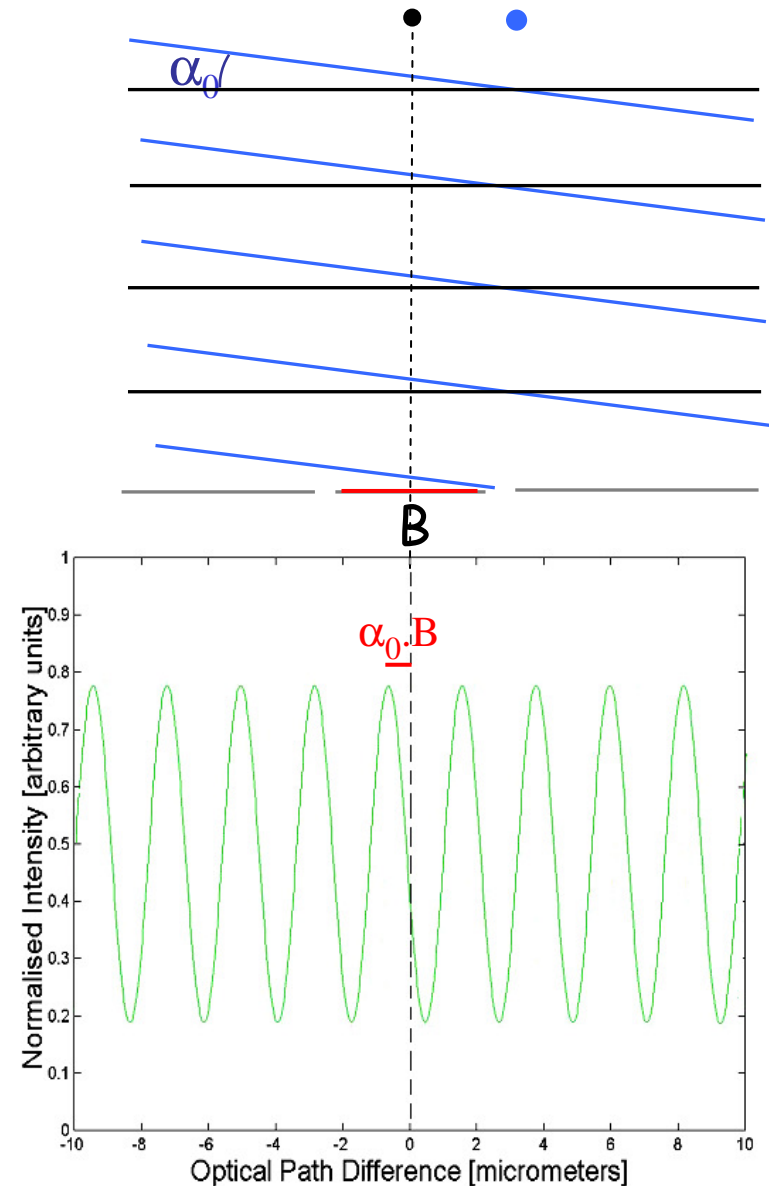
The Phase in Interferometry: $\mathbf{V} = V e^{-i\phi}$



The Phase in Interferometry: $\mathbf{V} = V e^{-i\phi}$

- Binary source at angle $\alpha_0 \Rightarrow$
displacement of the fringes by $\text{OPD} = \alpha_0 \cdot B$

$$\phi = 2\pi \frac{\text{OPD}}{\lambda}$$



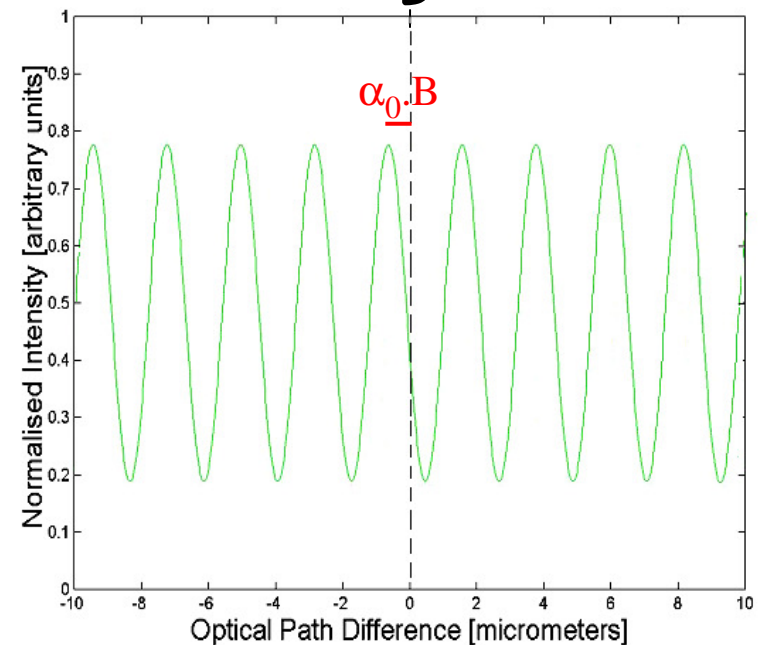
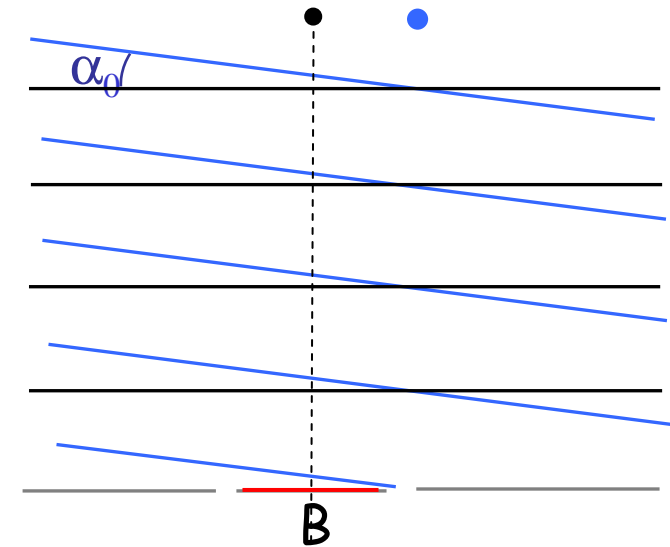
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Van Cittert-Zernike theorem

$$\phi(u, v) = \arg[\hat{O}(u, v)] = \text{atan}[\text{Im}(\hat{O})/\text{Re}(\hat{O})]$$



The Phase in Interferometry: $\mathbf{V} = V e^{-i\phi}$

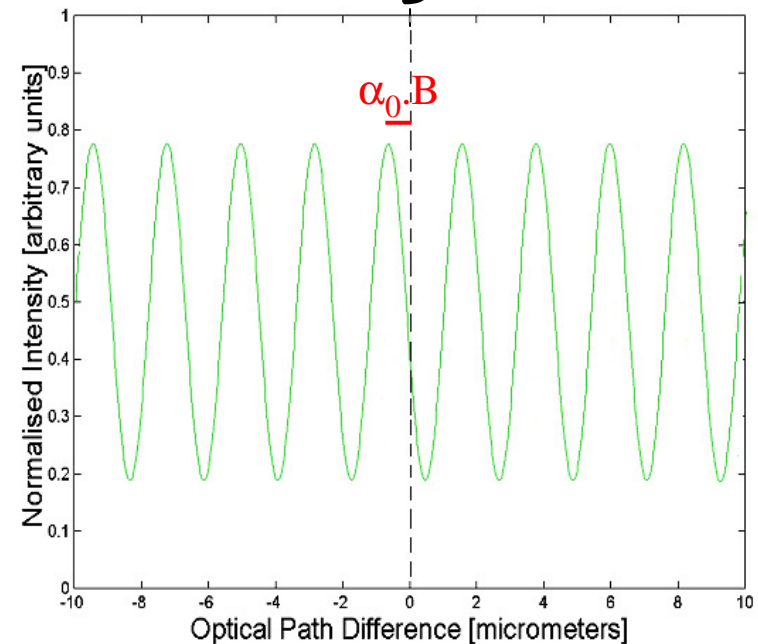
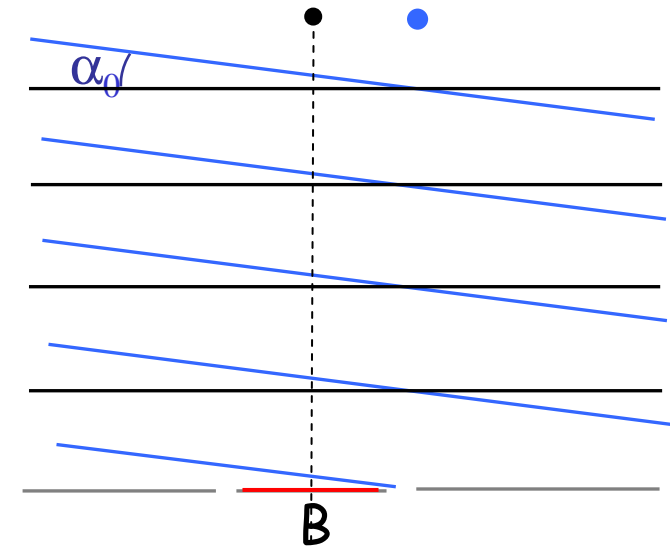
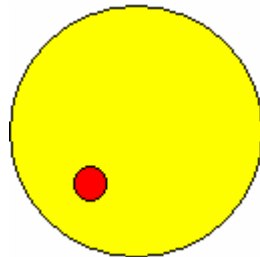
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Van Cittert-Zernike theorem

$$\phi(u, v) = \arg[\hat{O}(u, v)] = \text{atan}[\text{Im}(\hat{O})/\text{Re}(\hat{O})]$$

information on the
asymmetries of an object



The Phase in Interferometry: $\mathbf{V} = V e^{-i\phi}$

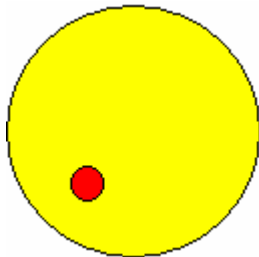
- Binary source at angle $\alpha_0 \Rightarrow$ displacement of the fringes by $\text{OPD} = \alpha_0 \cdot B$

$$\phi = 2\pi \frac{\text{OPD}}{\lambda}$$

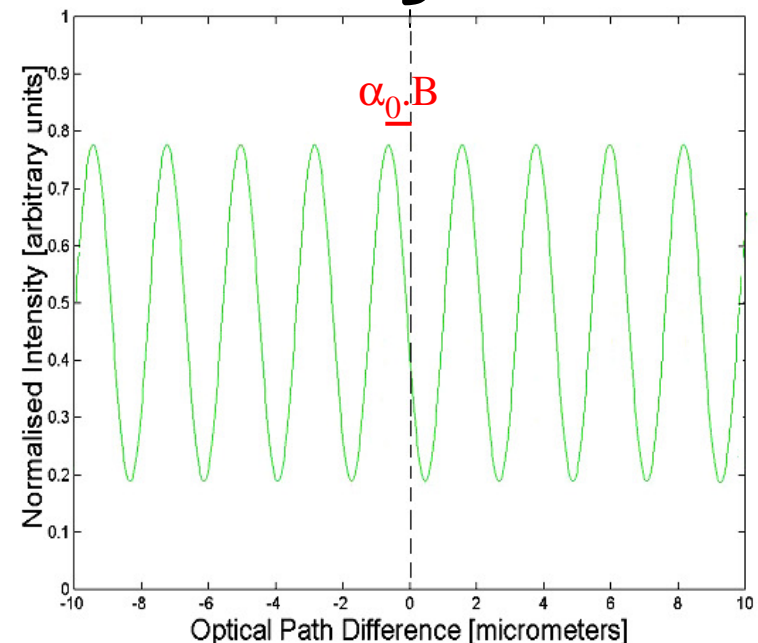
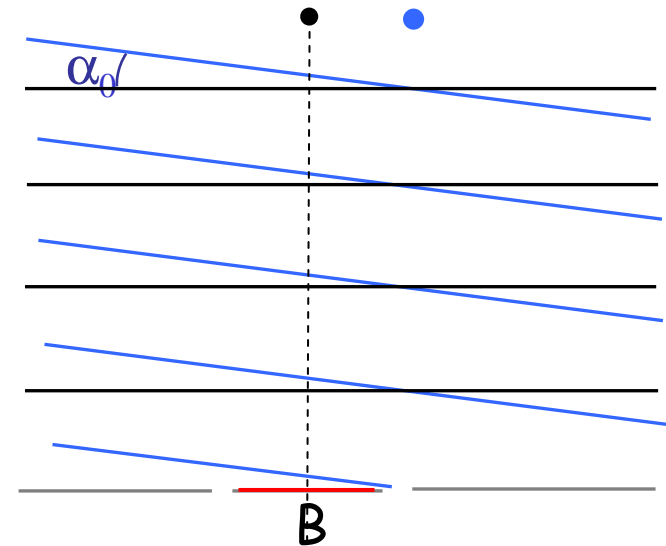
Van Cittert-Zernike theorem

$$\phi(u, v) = \arg[\hat{O}(u, v)] = \text{atan}[\text{Im}(\hat{O})/\text{Re}(\hat{O})]$$

information on the
asymmetries of an object



$$\phi^{12} = \phi^{12}_{obj} + \delta_2 - \delta_1$$



The Phase in Interferometry: $\mathbf{V} = V e^{-i\phi}$

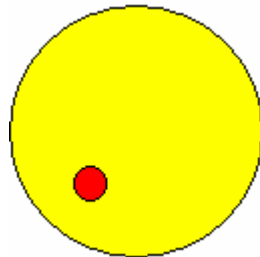
- Binary source at angle $\alpha_0 \Rightarrow$ displacement of the fringes by $\text{OPD} = \alpha_0 \cdot B$

$$\phi = 2\pi \frac{\text{OPD}}{\lambda}$$

Van Cittert-Zernike theorem

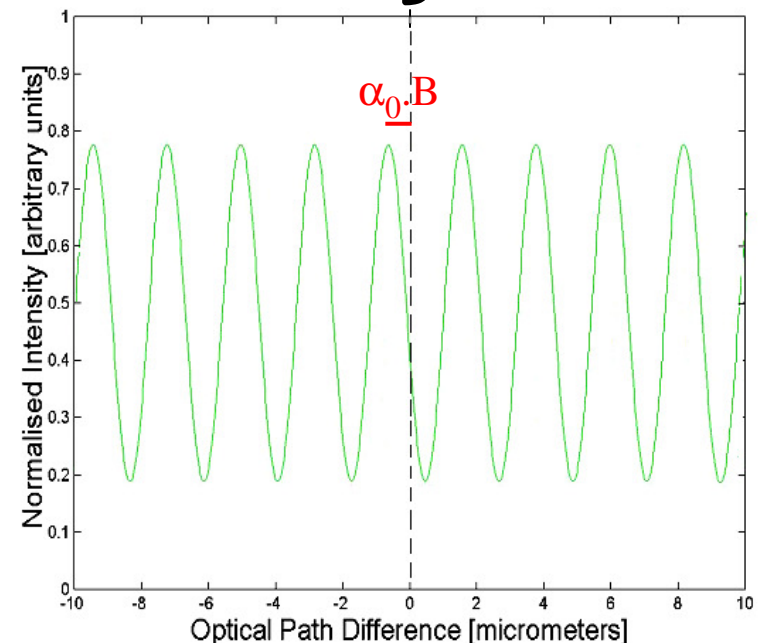
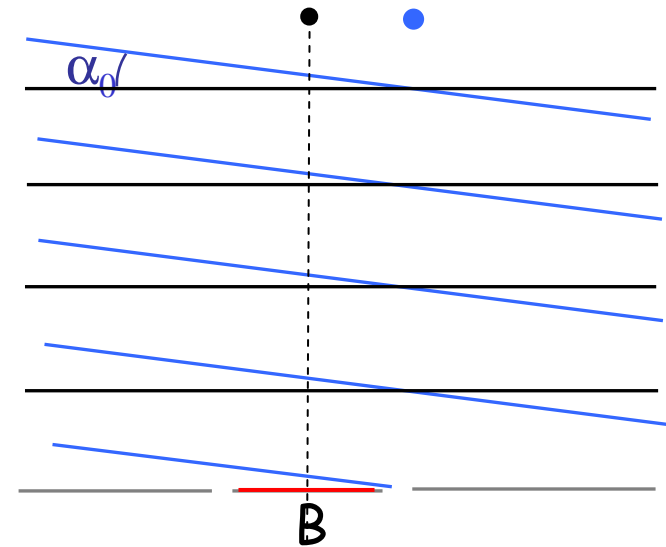
$$\phi(u, v) = \arg[\hat{O}(u, v)] = \text{atan}[\text{Im}(\hat{O}) / \text{Re}(\hat{O})]$$

information on the asymmetries of an object

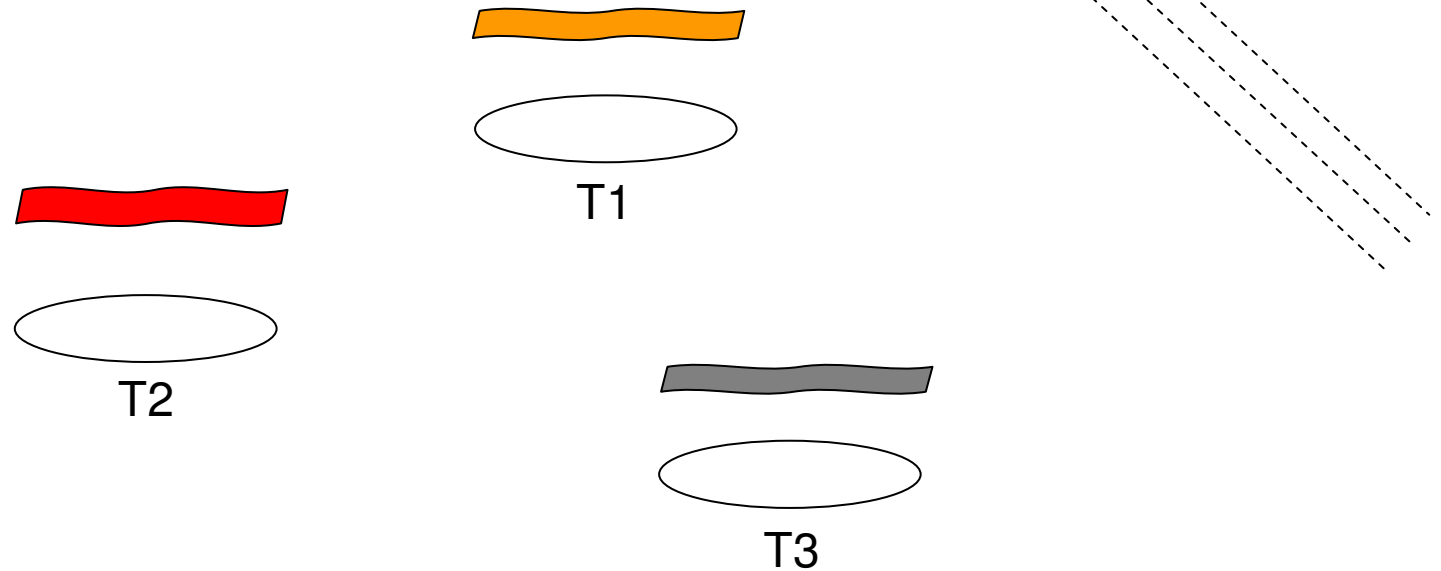


$$\phi^{12} = \phi^{12}_{obj} + \boxed{\delta_2 - \delta_1}$$

Atmospheric noise



The Closure Phase



Observed Object Atmosphere

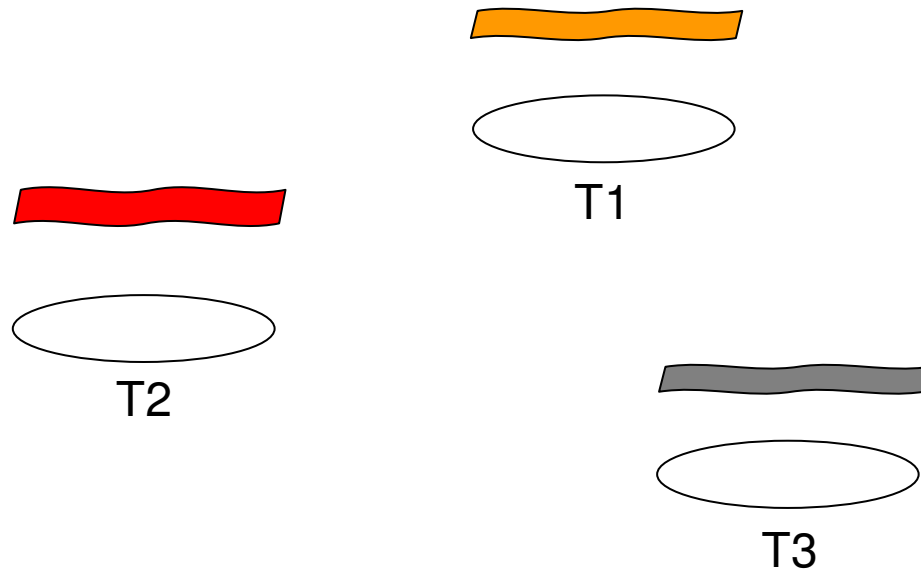
$$\phi^{12} = \phi_{obj}^{12} + \delta_2 - \delta_1$$

$$\phi^{23} = \phi_{obj}^{23} + \delta_3 - \delta_2$$

$$\phi^{31} = \phi_{obj}^{31} + \delta_1 - \delta_3$$

$$\phi_{123} = \phi^{12} + \phi^{23} + \phi^{31} = \phi_{obj}^{12} + \phi_{obj}^{23} + \phi_{obj}^{31}$$

The Closure Phase



Observed Object Atmosphere

$$\phi^{12} = \phi_{obj}^{12} + \delta_2 - \delta_1$$

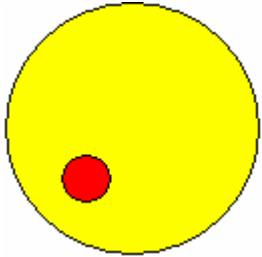
$$\phi^{23} = \phi_{obj}^{23} + \delta_3 - \delta_2$$

$$\phi^{31} = \phi_{obj}^{31} + \delta_1 - \delta_3$$

$$\phi_{123} = \phi^{12} + \phi^{23} + \phi^{31} = \phi_{obj}^{12} + \phi_{obj}^{23} + \phi_{obj}^{31}$$

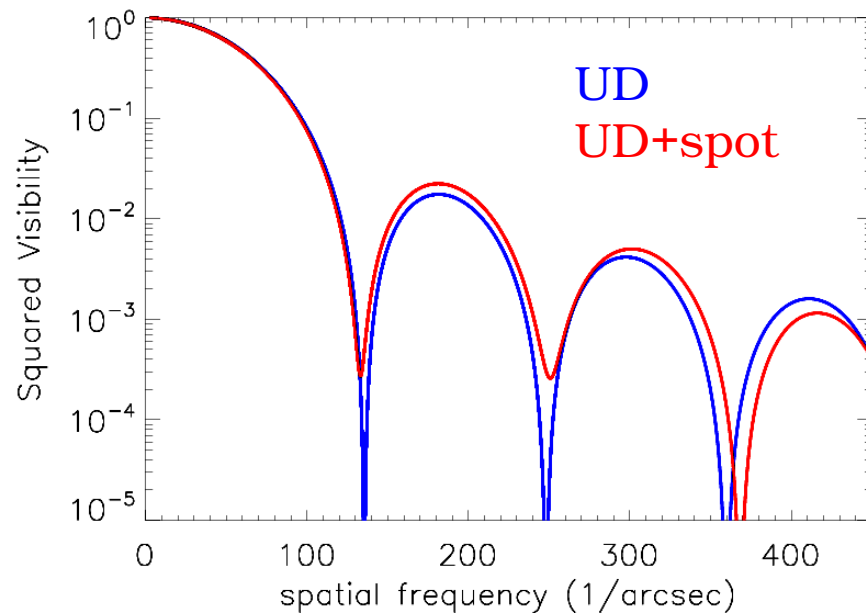
Object Only!!

An Example

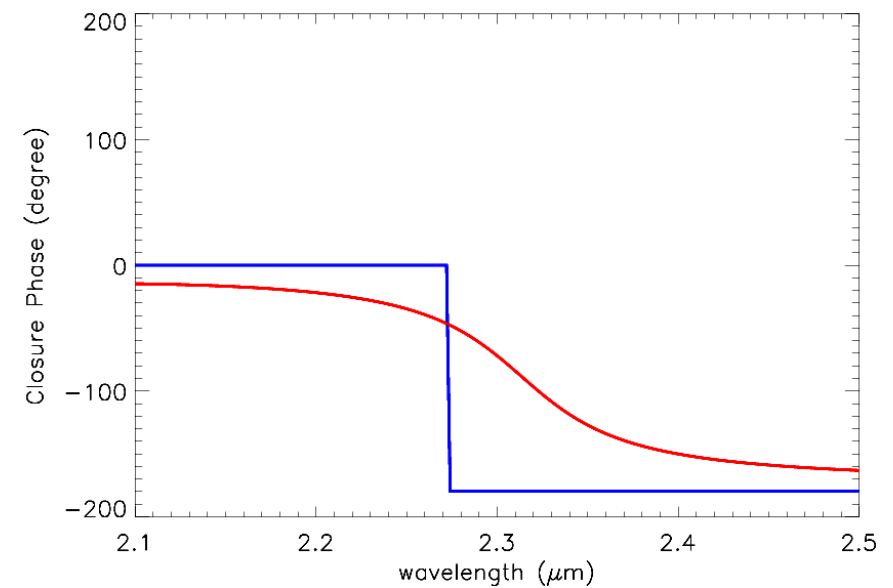


UD of 9 mas diameter with a spot of **2 mas** diameter on its surface representing **25%** of the total flux.

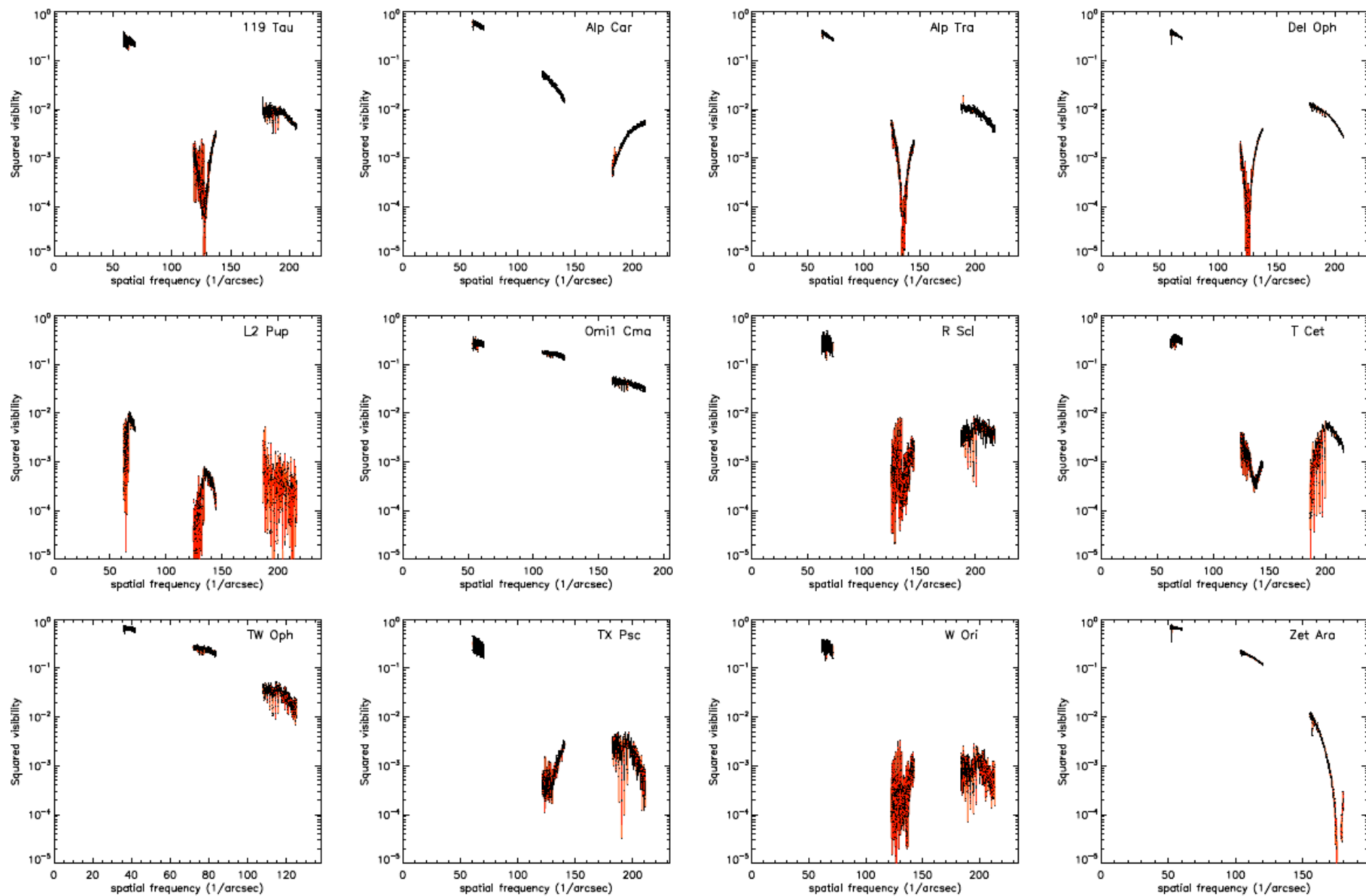
Fringe contrast



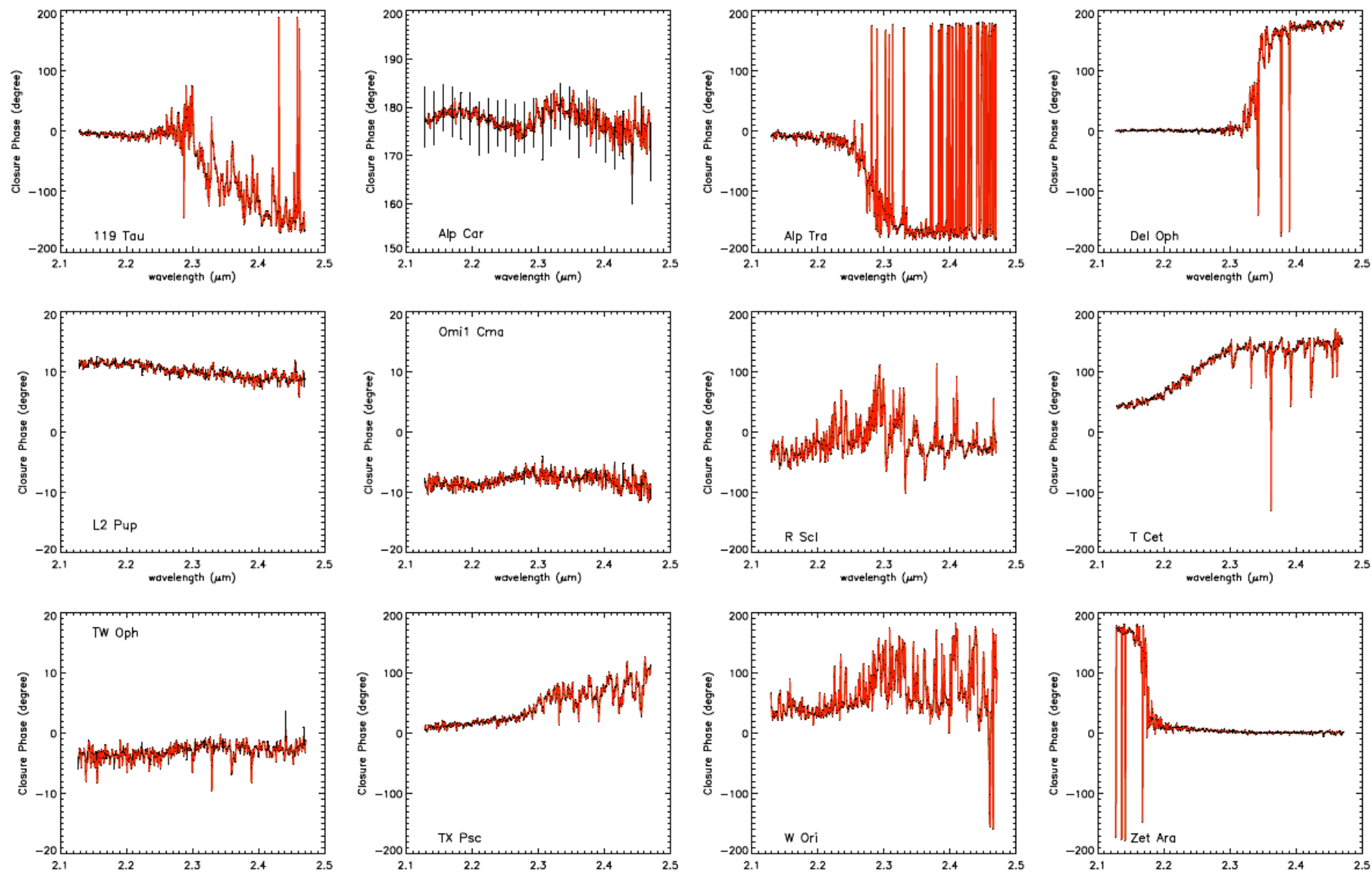
Closure Phase



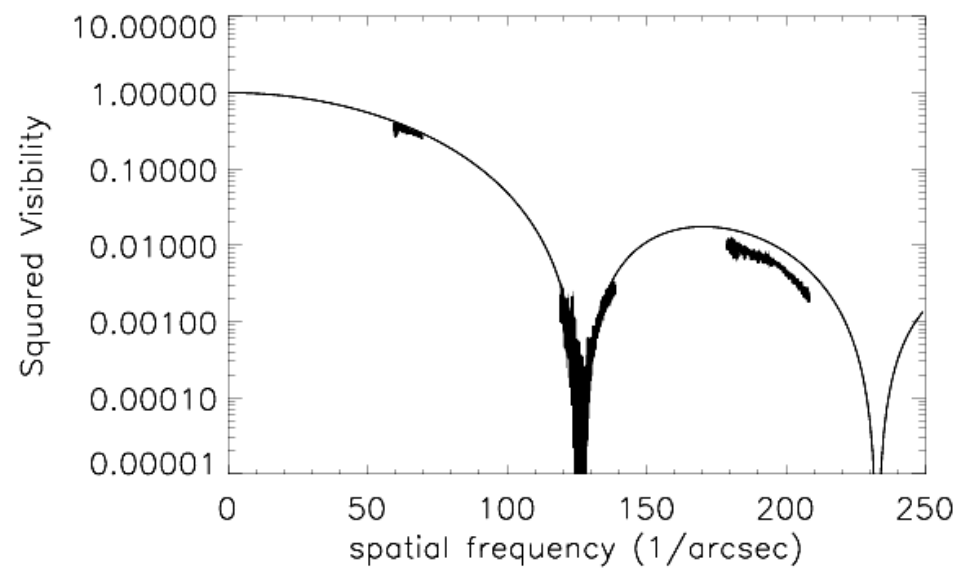
Real visibility data points (AMBER with 3 telescopes)



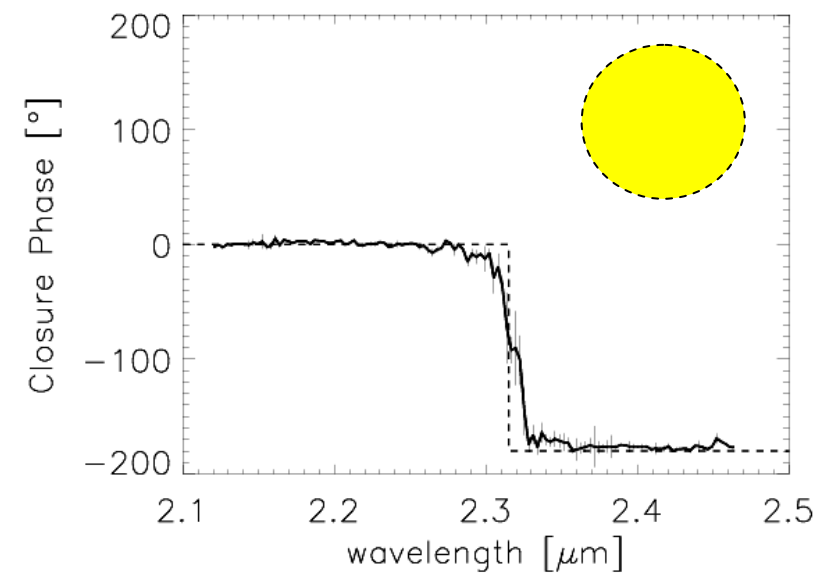
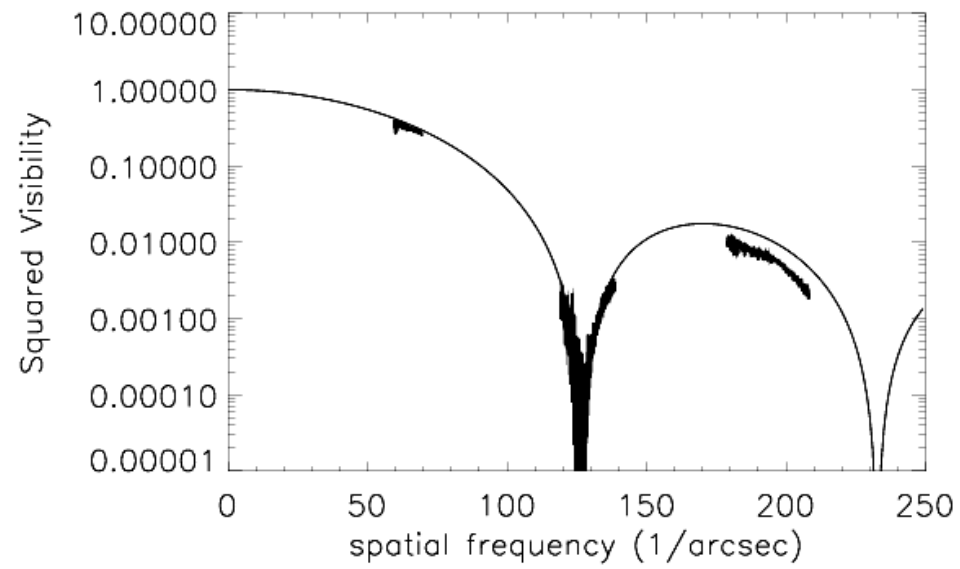
Closure Phase data



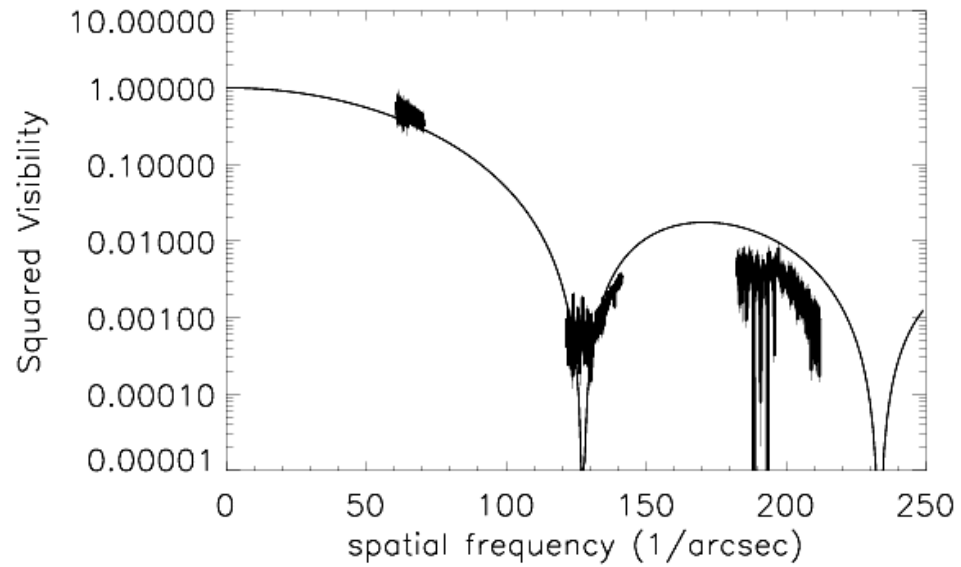
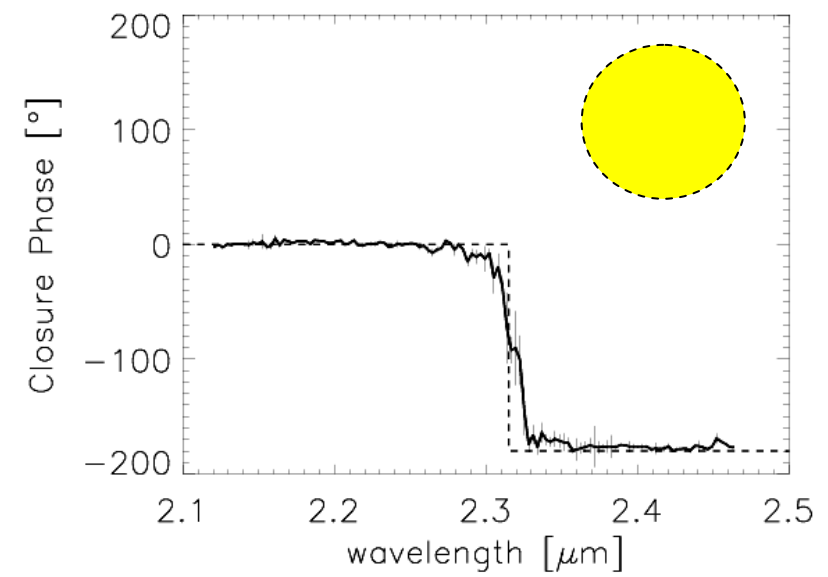
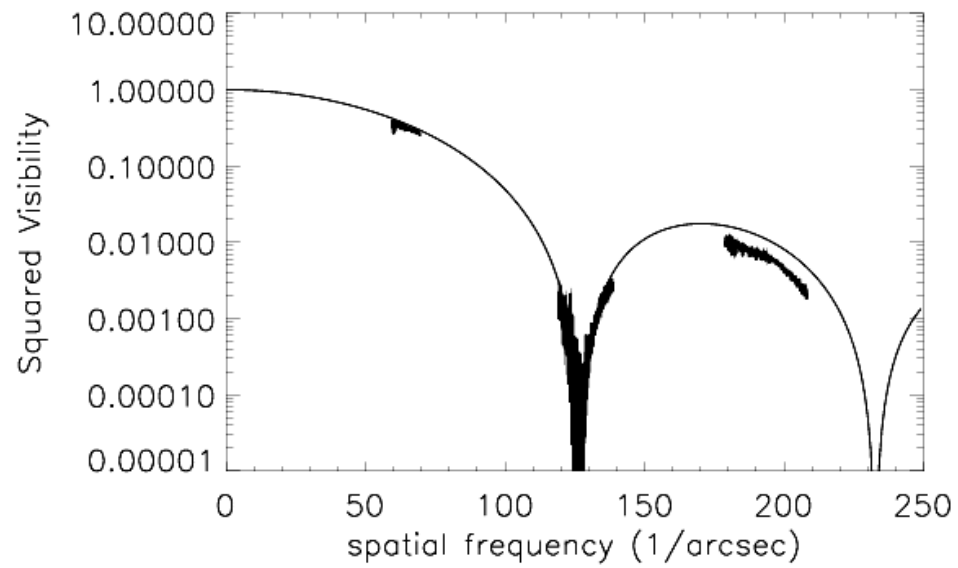
Model vs Data (part I)



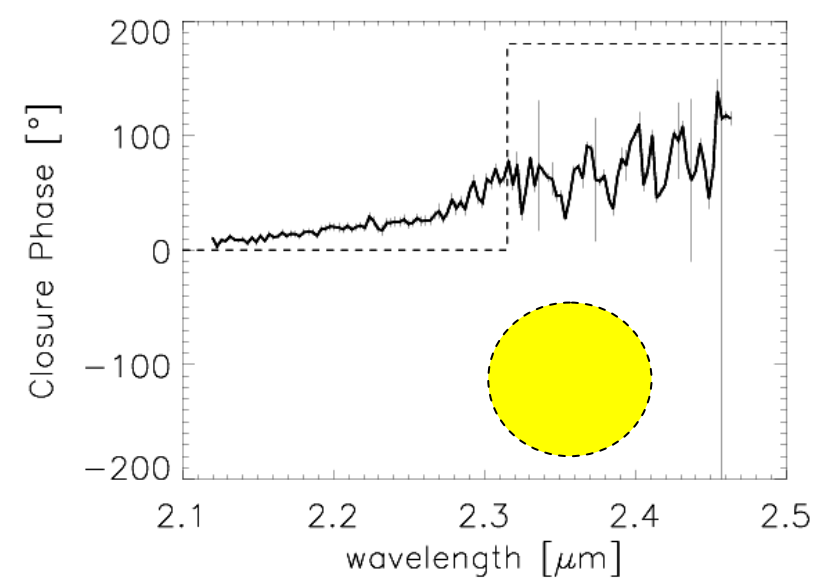
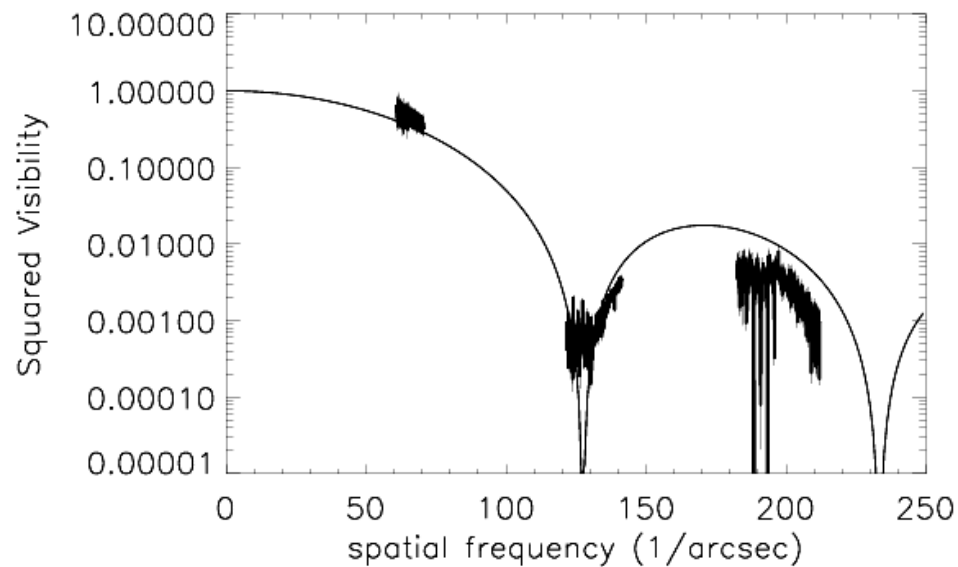
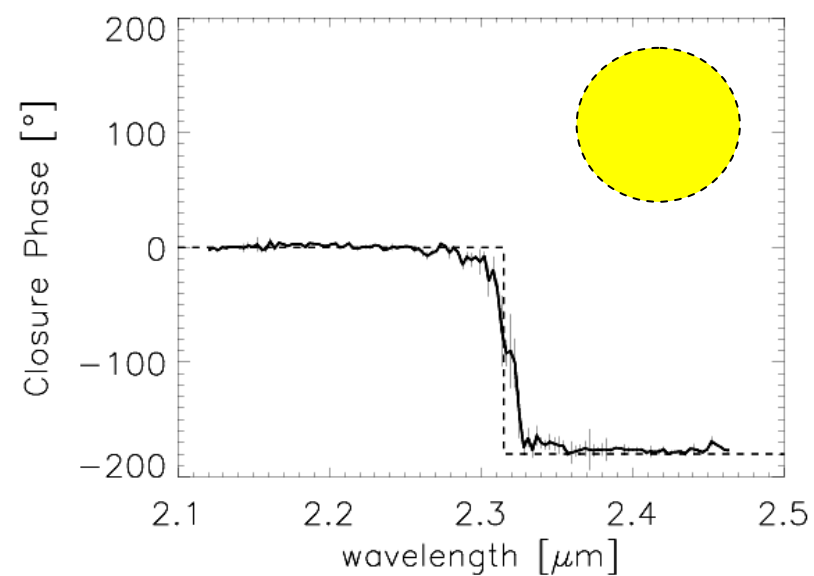
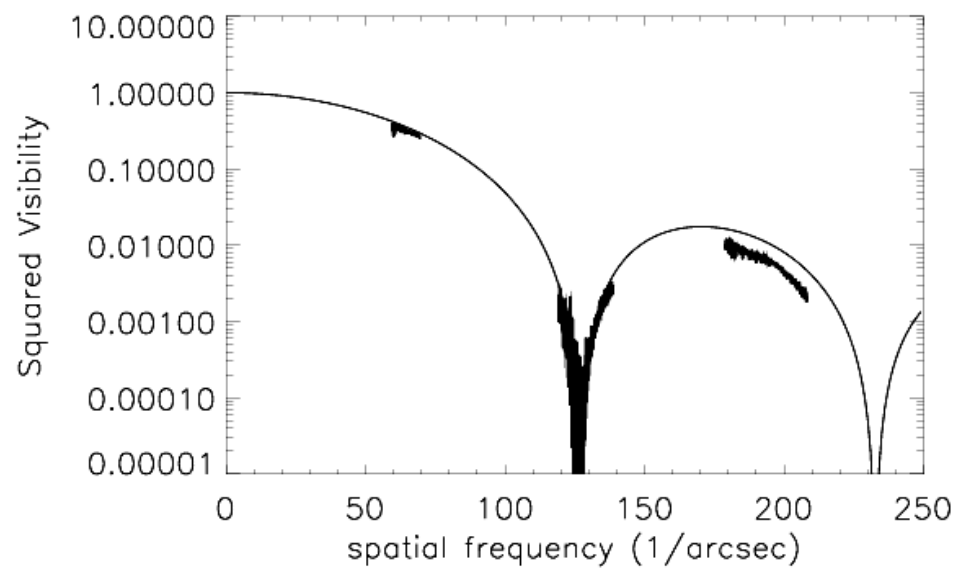
Model vs Data (part I)



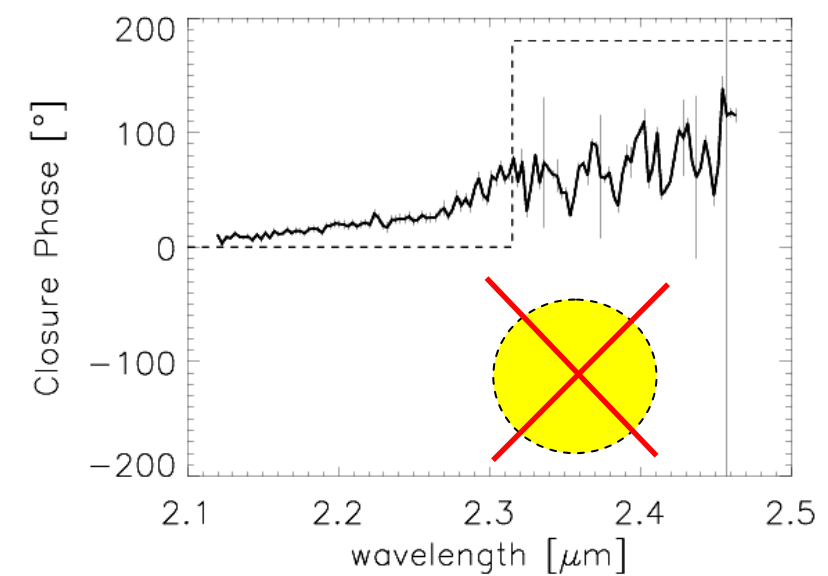
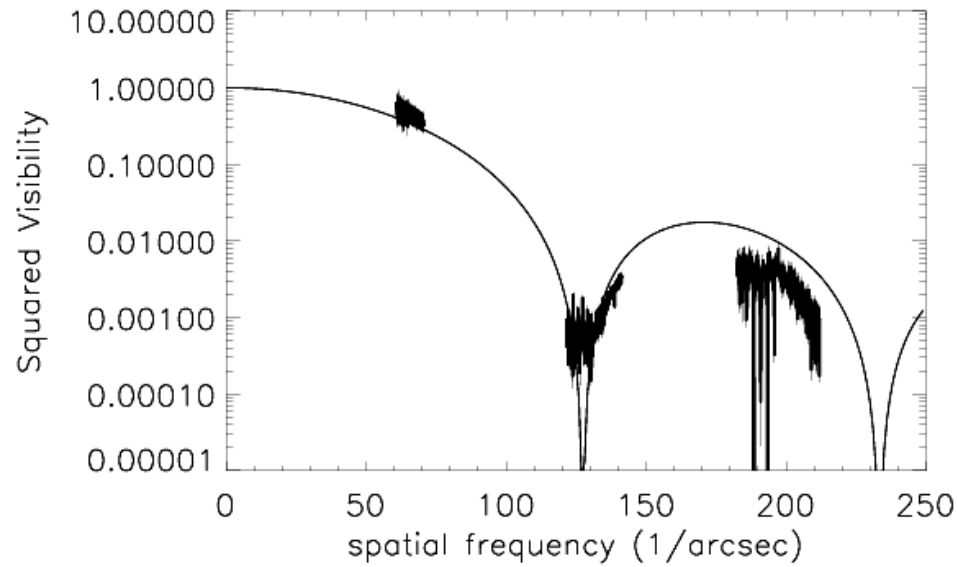
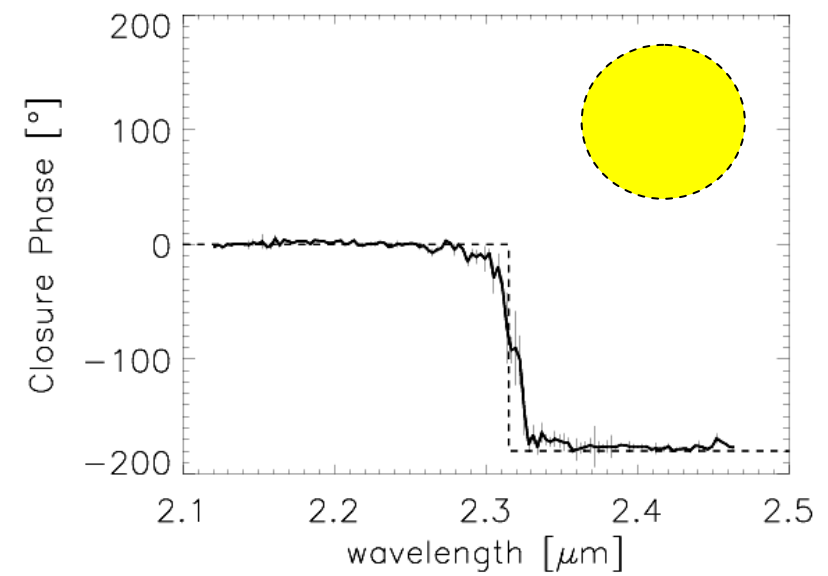
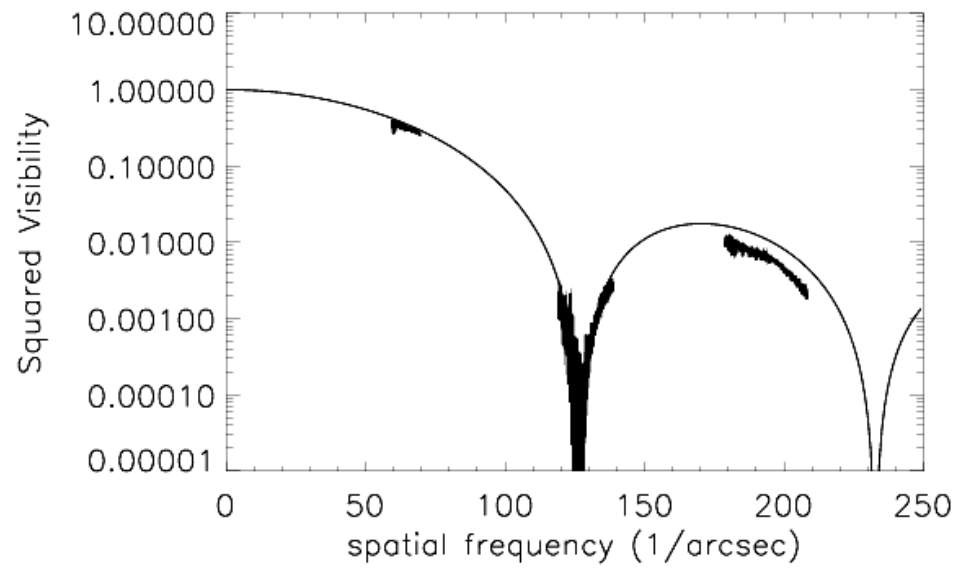
Model vs Data (part I)



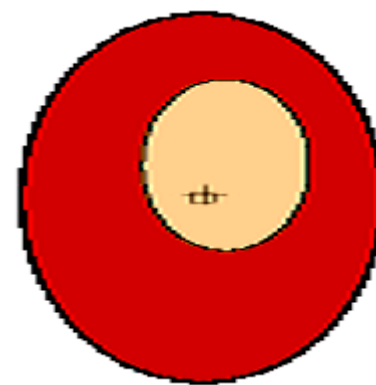
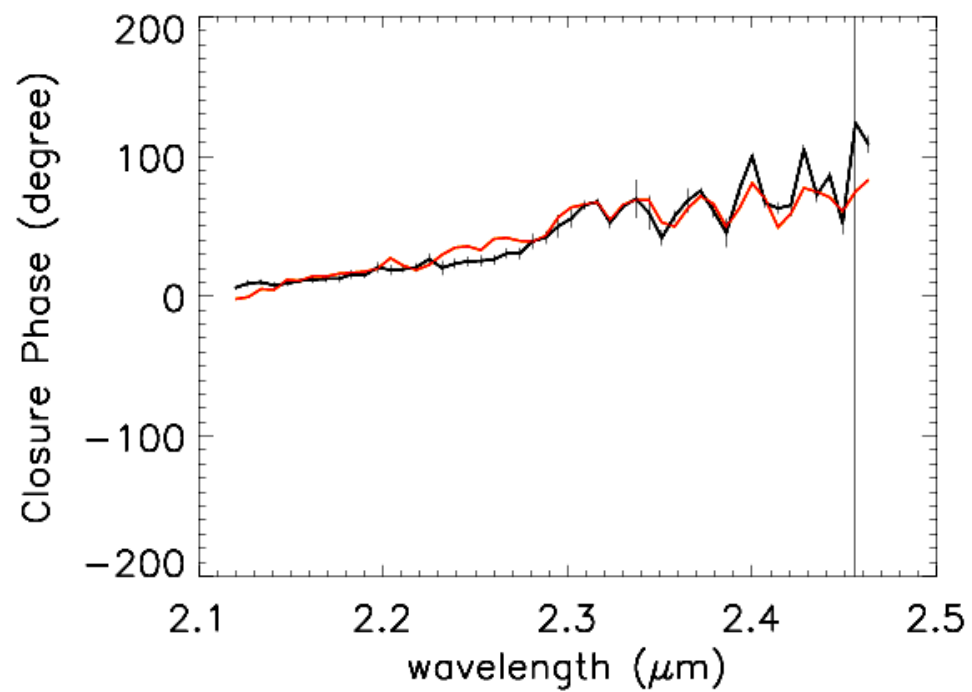
Model vs Data (part I)



Model vs Data (part I)

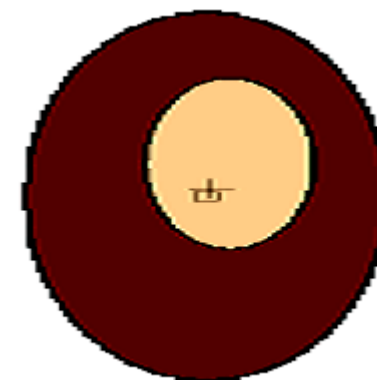


Model vs Data (part II)



2.17 μm
continuum

10 mas



2.38 μm
CO-line

The calibration in Interferometry

The need for accurate determination of the calibrator diameters

Calibrated visibility

$$V = \frac{V_{\text{sci,raw}}}{R_v}$$

where

System response

$$R_v = \frac{V_{\text{cal,raw}}}{V_{\text{cal,model}}}$$

The need for accurate determination of the calibrator diameters

Calibrated visibility

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where

System response

$$R_v = \frac{V_{\text{cal,raw}}}{V_{\text{cal,model}}}$$

Unresolved calibrator

$$V_{\text{cal,model}} = 1$$

***Error on visibility
solely due to
uncertainty on the
calibrator diameter***

$$\frac{\Delta V}{V} = 0$$

The need for accurate determination of the calibrator diameters

Calibrated visibility

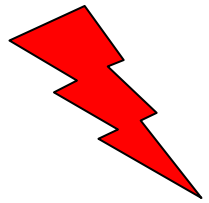
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Calibrated visibility

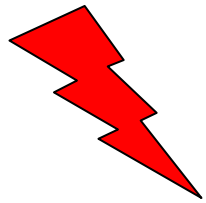
$$V = \frac{V_{\text{sci,raw}}}{R_v}$$

where

System response

$$R_v = \frac{V_{\text{cal,raw}}}{V_{\text{cal,model}}}$$

Unresolved calibrator



$$V_{\text{cal,model}} = 1$$

Resolved calibrator

$$V_{\text{cal,model}} = 2 \left| \frac{J_1 \left(\pi \phi_{\text{cal}} \frac{B_p}{\lambda} \right)}{\pi \phi_{\text{cal}} \frac{B_p}{\lambda}} \right|$$

***Error on visibility
solely due to
uncertainty on the
calibrator diameter***

$$\frac{\Delta V}{V} = 0$$

$$\frac{\Delta V}{V} = \frac{\pi B \phi_{\text{cal}}}{\lambda} \frac{J_2 \left(\frac{\pi B \phi_{\text{cal}}}{\lambda} \right)}{J_1 \left(\frac{\pi B \phi_{\text{cal}}}{\lambda} \right)} \frac{\Delta \phi_{\text{cal}}}{\phi_{\text{cal}}}$$

The need for accurate determination of the calibrator diameters

Calibrated visibility

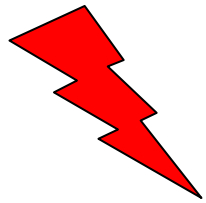
$$V = \frac{V_{\text{sci,raw}}}{R_v}$$

where

System response

$$R_v = \frac{V_{\text{cal,raw}}}{V_{\text{cal,model}}}$$

Unresolved calibrator



$$V_{\text{cal,model}} = 1$$

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$$V_{\text{cal,model}} = 2 \left| \frac{J_1 \left(\pi \phi_{\text{cal}} \frac{B_p}{\lambda} \right)}{\pi \phi_{\text{cal}} \frac{B_p}{\lambda}} \right|$$

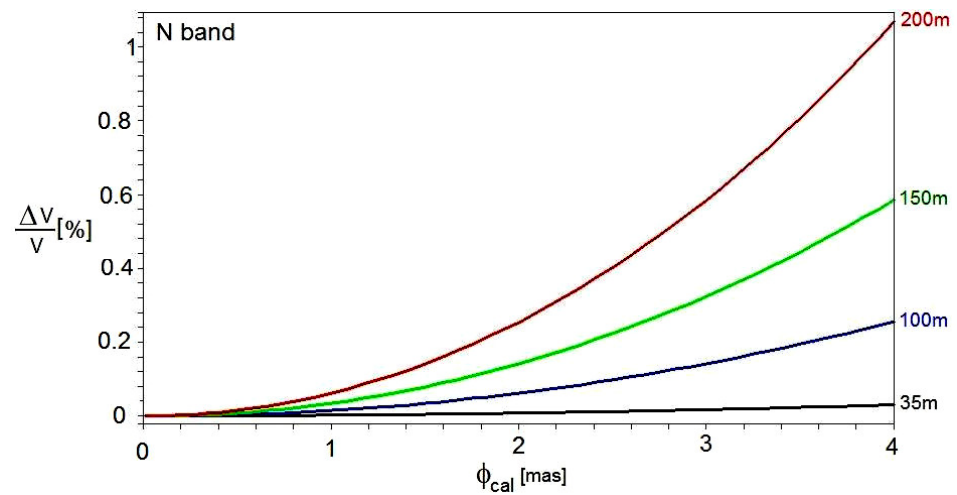
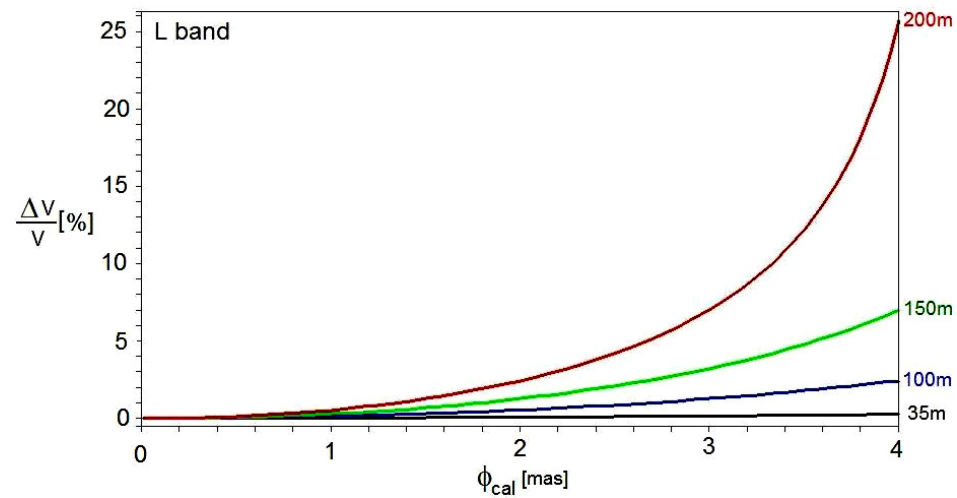
***Error on visibility
solely due to
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calibrator diameter***

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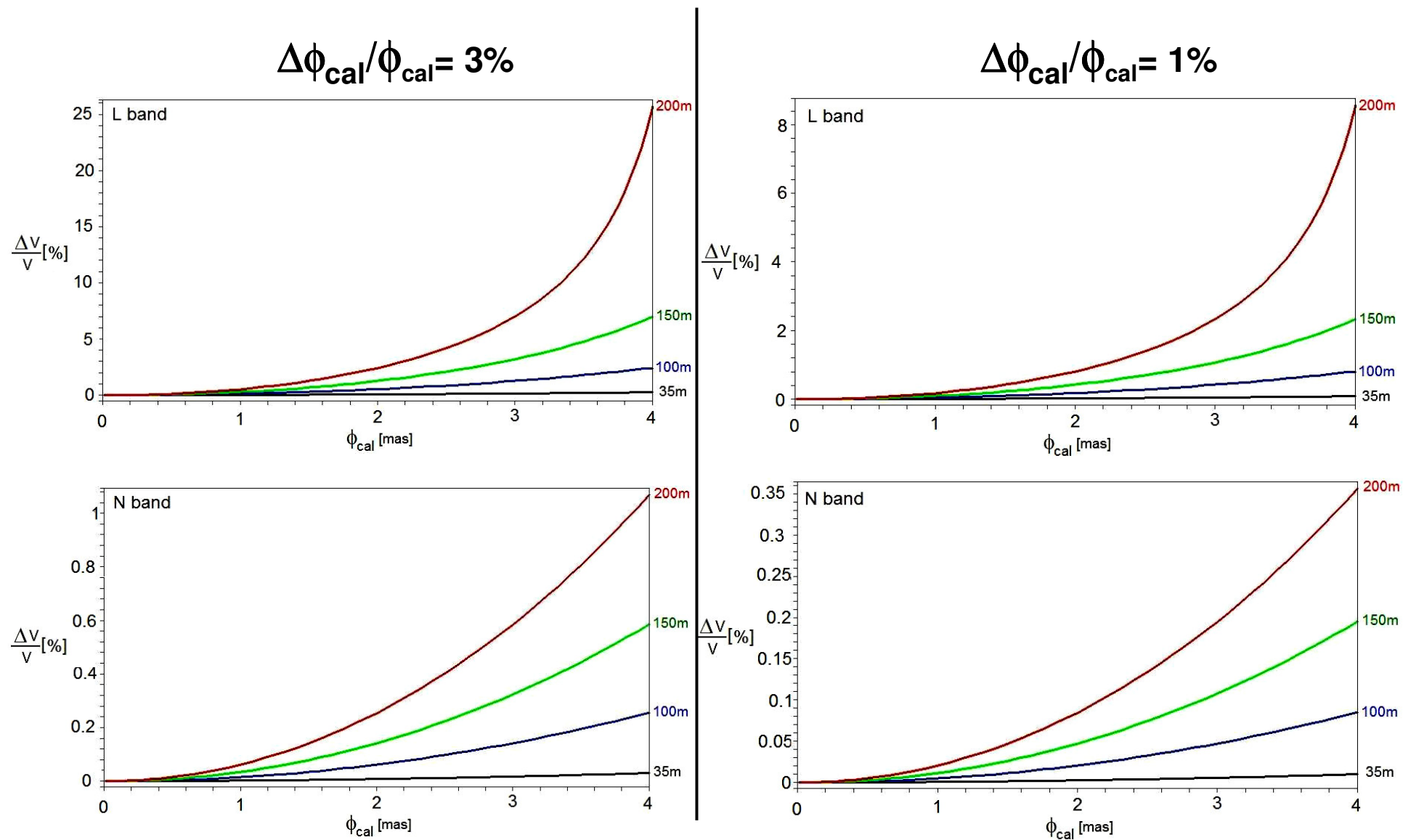
$$\frac{\Delta V}{V} = \frac{\pi B \phi_{\text{cal}}}{\lambda} \frac{J_2 \left(\frac{\pi B \phi_{\text{cal}}}{\lambda} \right)}{J_1 \left(\frac{\pi B \phi_{\text{cal}}}{\lambda} \right)} \frac{\Delta \phi_{\text{cal}}}{\phi_{\text{cal}}}$$

Effects of diameter uncertainties on the visibility accuracy

$$\Delta\phi_{\text{cal}}/\phi_{\text{cal}} = 3\%$$



Effects of diameter uncertainties on the visibility accuracy




ASPRO

The Astronomical Software to PRepare Observations

How to launch ASPRO in the web?

http://www.jmmc.fr/aspro_page.htm



JEAN-MARIE MARIOTTI CENTER
Infrared and Optical Interferometry for Astronomy

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Who are we ?

- Who was JMM ?
- Partners
- Structure
- Working groups

EII - JRA4

Training

Proposal preparation

- ASPRO
- SearchCal
- VLTI proposals

Data processing

- VINCI
- MIDI
- AMBER


User support

Site map

Development


ASPRO:

The Astronomical Software to PRepare Observations

 [subscribe to Aspro feed](#)

ASPRO is a complete software suite developed and maintained by the JMMC that allows to prepare interferometric observations with the VLTI or other interferometers. It allows in particular to simulate the projected baseline evolution during the observations (supersynthesis), derive the visibilities for a given object (single star, binaries, user defined FITS image,...), and offers many additional useful functions. A description of the JMMC Working Group on the development of ASPRO can be found on [this page](#).

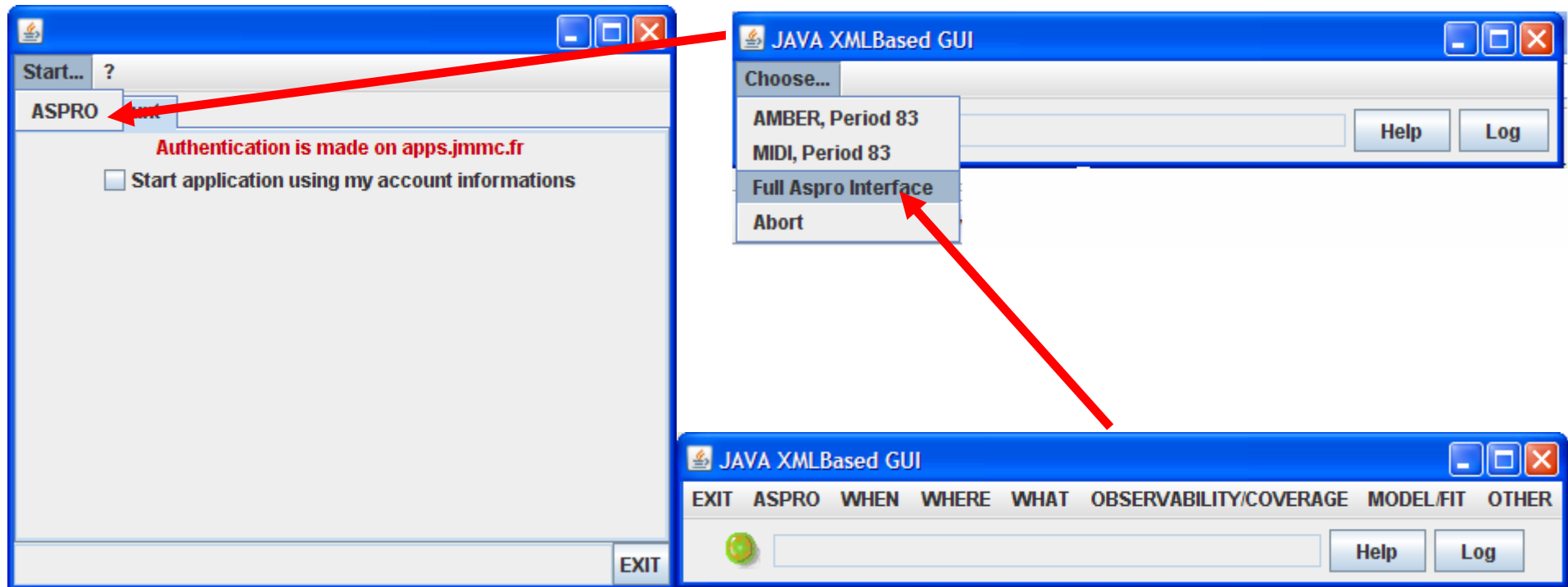
You can access the JMMC shared softwares running on our servers through [Java applications](#)



Java WebStart Application

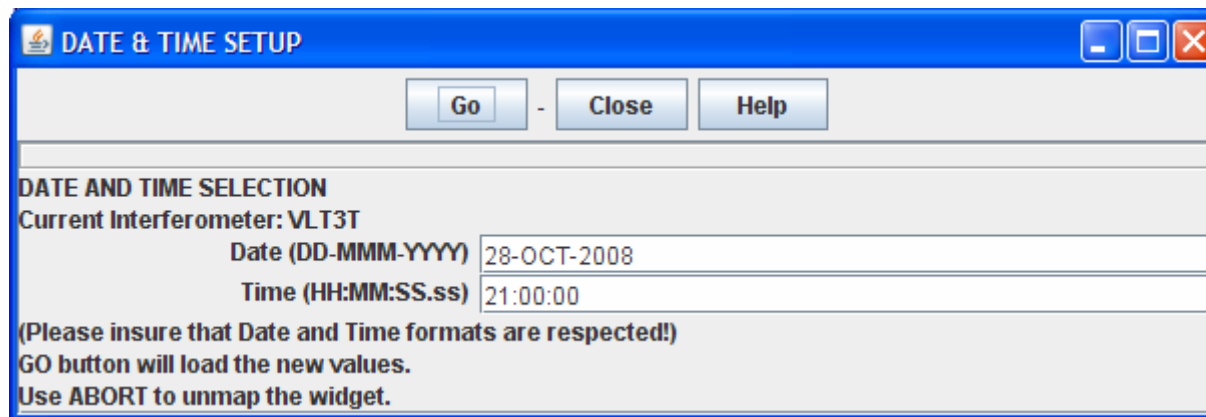
The java software used run ASPRO requires java web start. For more information about the installation of Java for your platform and the associated configurations, please refer to [this page](#). If you can't use java web start, please contact [User support](#) to find an issue with your configuration.

The interface

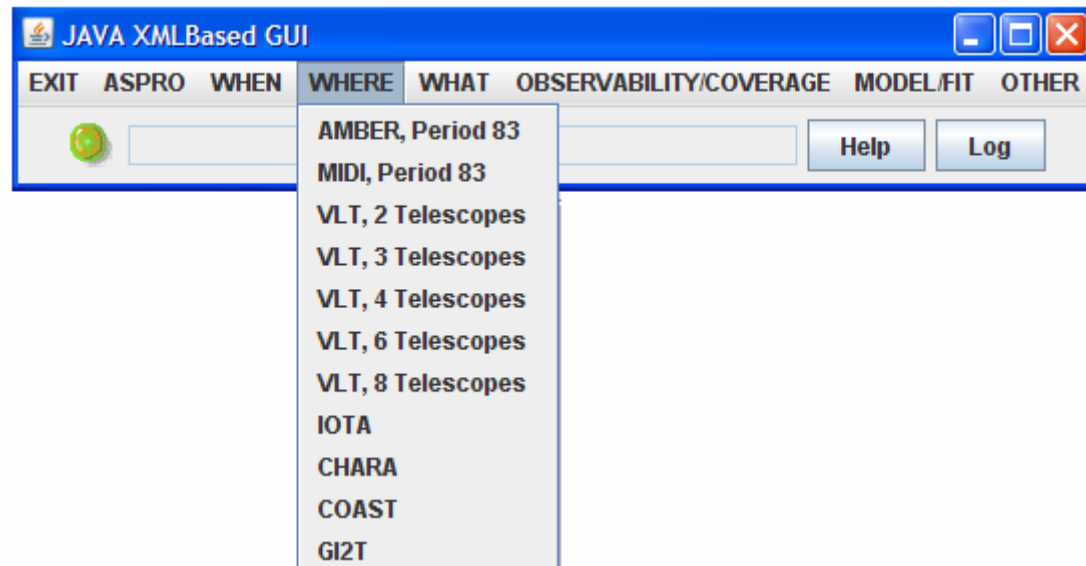


- **WHEN:** to define the date and time of the simulated observation
- **WHERE:** to select the interferometer (VLTI, IOTA, CHARA, ...) and the number of telescopes
- **WHAT:** to define the target properties (name, coordinates, brightness);
- **OBSERVABILITY/COVERAGE:** to define the VLTI configuration to be used for the observations
- **MODEL/FIT:** to calculate and plot interferometric observables and their associated uncertainties according to the chosen model (UD, LD, Binary, ...) and the corresponding baseline configuration.

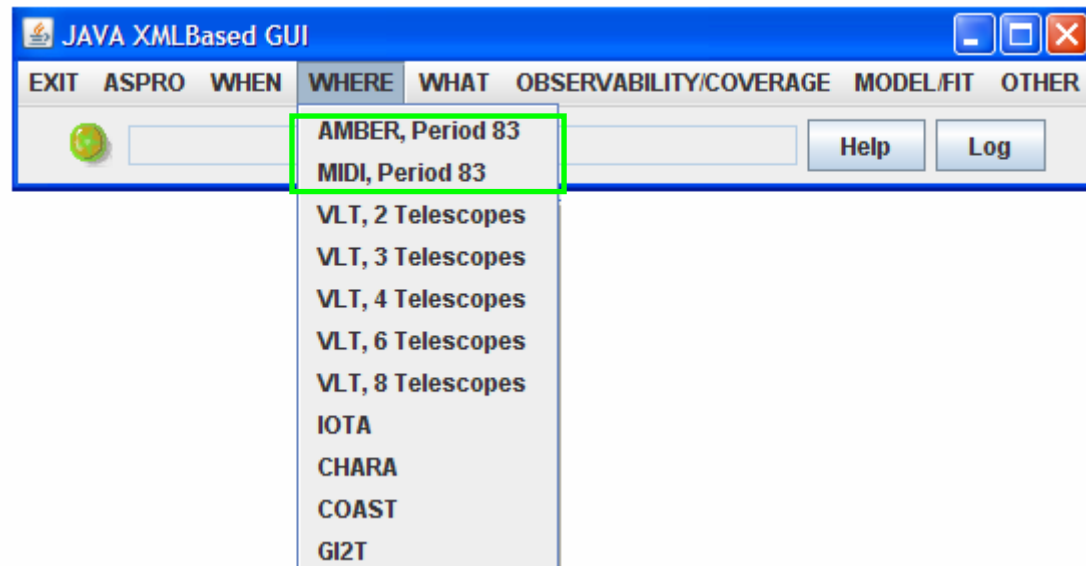
When



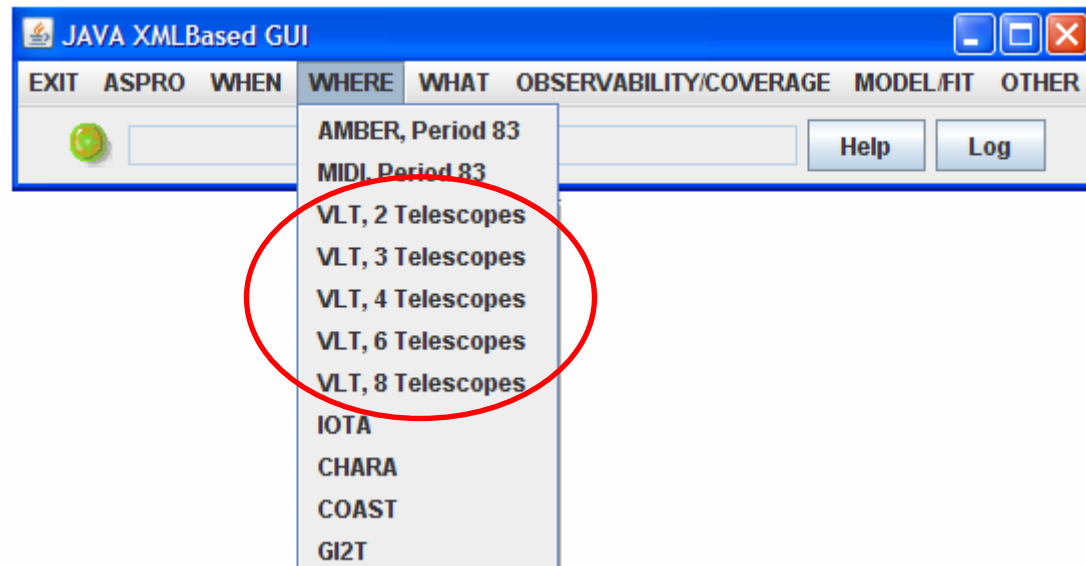
Where



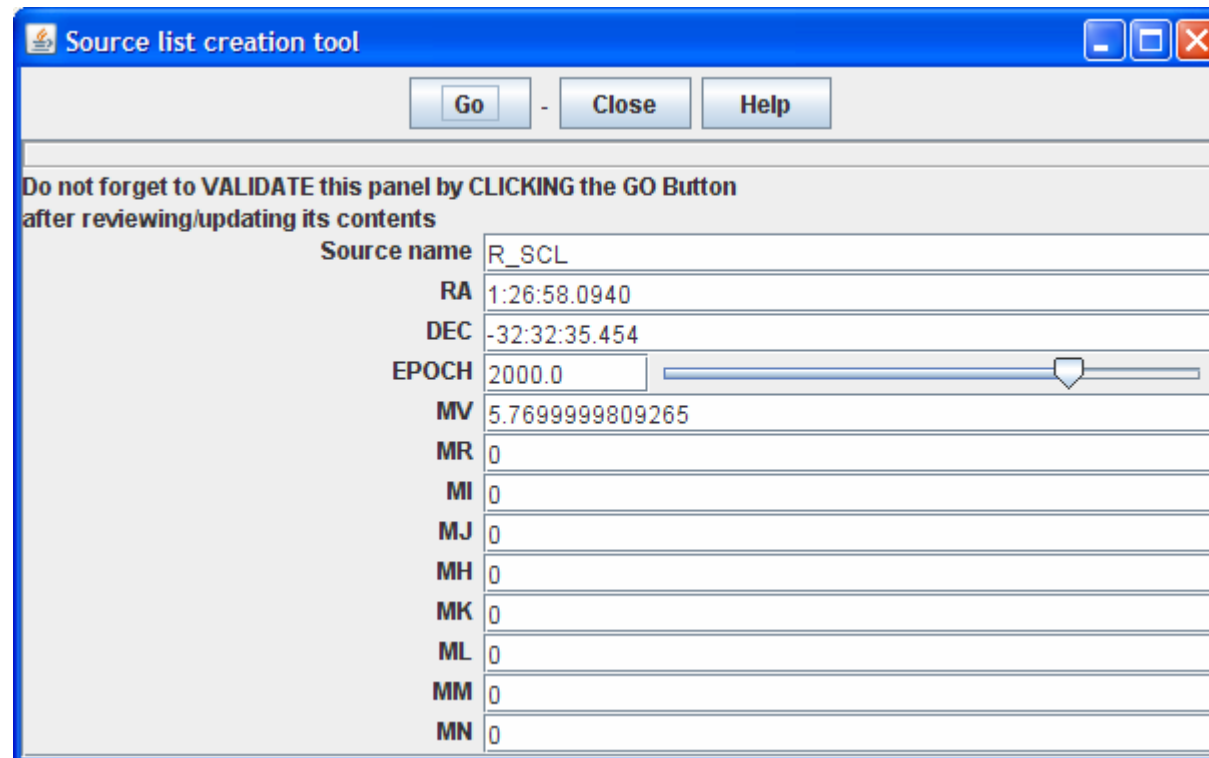
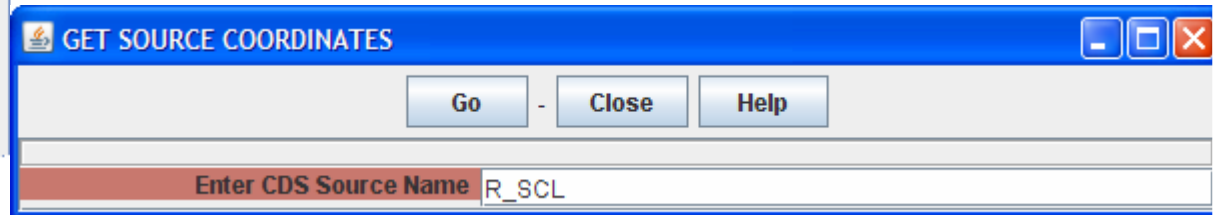
Where



Where



What



Observability

The image shows a Java-based graphical user interface for astronomical observability calculations. The main window, titled "OBSERVABILITY OF OBJECTS", contains several configuration options. At the top, there are buttons for "Go", "Close", and "Help". Below these are three buttons: "VIEW CATALOG", "CHANGE CATALOG", and "CHANGE INTERFEROMETER". The "Current Source Catalog" is set to "oipt_sources.sou". The "Min. Elevation ?" is set to 30.0, with a corresponding slider. The "Plot Twilights zones" checkbox is checked, and the "Add Planets to Plot" checkbox is unchecked. The "Interferometer configuration" section includes fields for "Telescope #1 Name" (U1) and "Telescope #2 Name" (U2), each with a dropdown menu. The "Time-stamp DL availability zones" checkbox is unchecked. The "Date (DD-MMM-YYYY)" is set to 28-OCT-2008. A secondary window, titled "JAVA XMLBased GUI", is open above the main window, showing a menu with options: "EXIT", "ASPRO", "WHEN", "WHERE", "WHAT", "OBSERVABILITY/COVERAGE", "MODEL/FIT", and "OTHER". The "OBSERVABILITY/COVERAGE" menu is expanded, showing sub-options: "Observability of Sources", "Observability Limits Due To Delay Lines", "All-Sky Observability Limits", and "UV Coverage & PSF".

JAVA XMLBased GUI

EXIT ASPRO WHEN WHERE WHAT OBSERVABILITY/COVERAGE MODEL/FIT OTHER

Observability of Sources

Observability Limits Due To Delay Lines

All-Sky Observability Limits

UV Coverage & PSF

OBSERVABILITY OF OBJECTS

Go - Close Help

VIEW CATALOG CHANGE CATALOG CHANGE INTERFEROMETER

Current Source Catalog: oipt_sources.sou

Min. Elevation ? 30.0

Plot Twilights zones ☒

Add Planets to Plot ☐

Interferometer configuration

Telescope #1 Name: U1

Telescope #2 Name: U2

Time-stamp DL availability zones ☐

Date (DD-MMM-YYYY): 28-OCT-2008

Observability

The image shows a Java XMLBased GUI with a menu bar (EXIT, ASPRO, WHEN, WHERE, WHAT, OBSERVABILITY/COVERAGE, MODEL/FIT, OTHER) and a toolbar. The 'OBSERVABILITY/COVERAGE' menu is open, showing options: Observability of Sources, Observability Limits Due To Delay Lines, All-Sky Observability Limits, and UV Coverage & PSF.

The 'OBSERVABILITY OF OBJECTS' window contains the following controls:

- Buttons: Go, Close, Help
- Buttons: VIEW CATALOG, CHANGE CATALOG, CHANGE INTERFEROMETER
- Current Source Catalog:
- Min. Elevation ? (circled in red)
- Plot Twilights zones ☒
- Add Planets to Plot ☐
- Interferometer configuration:
 - Telescope #1 Name:
 - Telescope #2 Name:
 - Time-stamp DL availability zones ☐
 - Date (DD-MMM-YYYY):

Observability

JAVA XMLBased GUI

EXIT ASPRO WHEN WHERE WHAT OBSERVABILITY/COVERAGE MODEL/FIT OTHER

Observability of Sources
Observability Limits Due To Delay Lines
All-Sky Observability Limits
UV Coverage & PSF

OBSERVABILITY OF OBJECTS

Go - Close Help

VIEW CATALOG CHANGE CATALOG CHANGE INTERFEROMETER

Current Source Catalog

Min. Elevation ?

Plot Twilights zones ☒

Add Planets to Plot ☐

Interferometer configuration

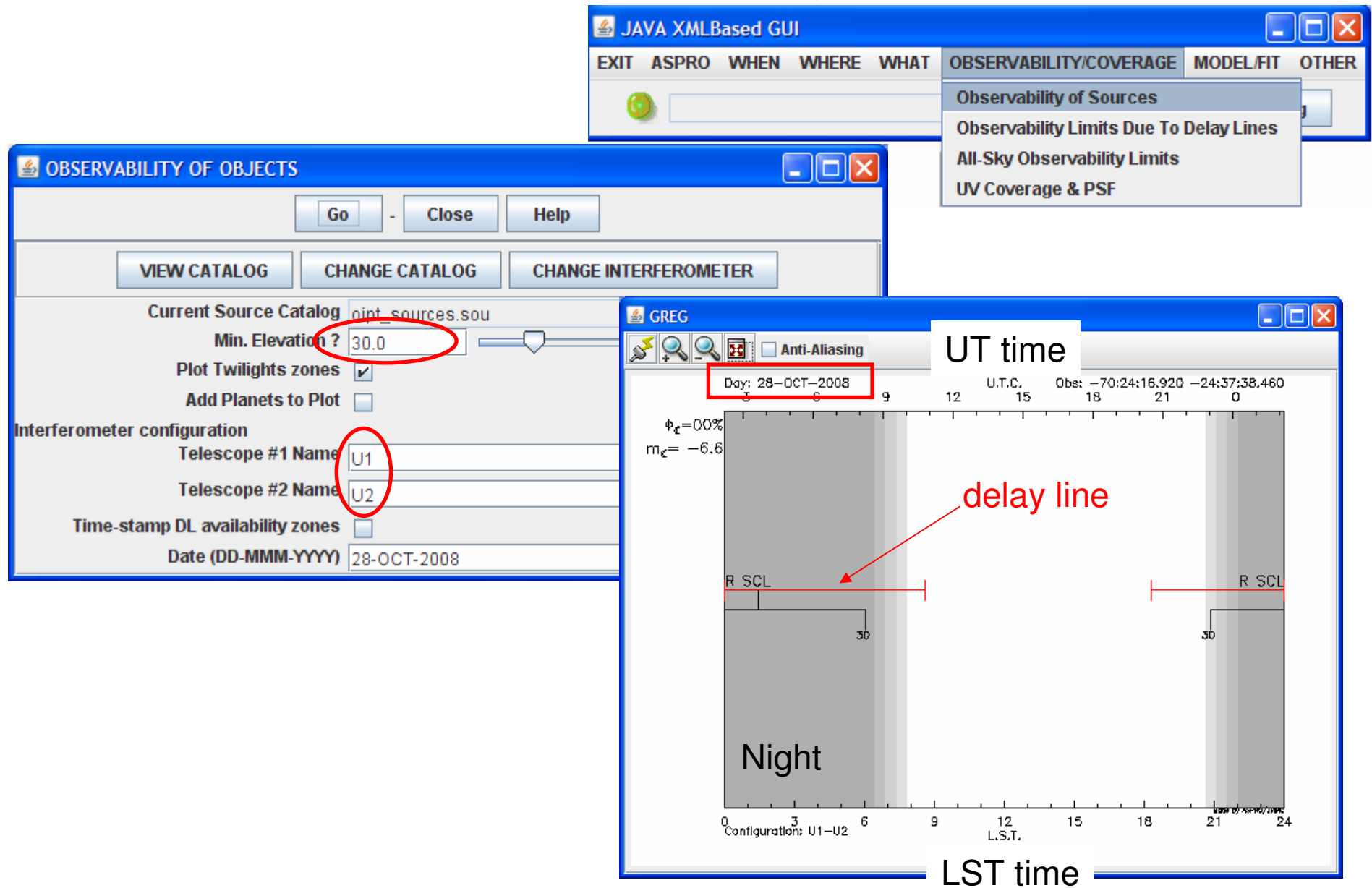
Telescope #1 Name

Telescope #2 Name

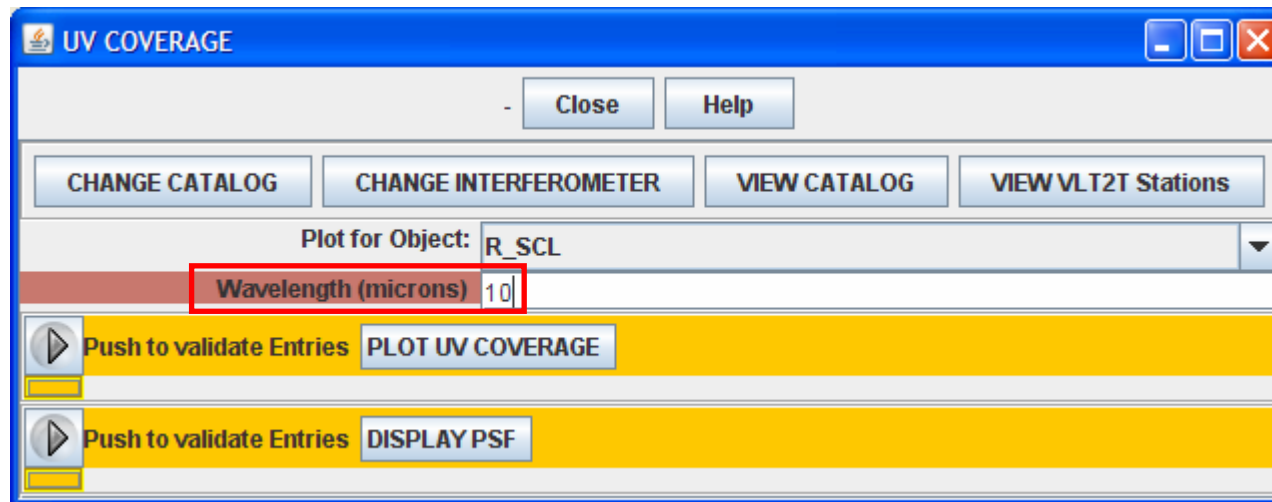
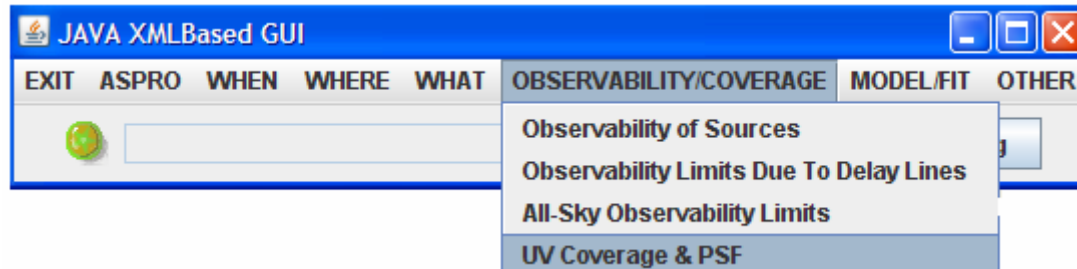
Time-stamp DL availability zones ☐

Date (DD-MMM-YYYY)

Observability



uv-coverage (part I)



uv-coverage (part II)

The screenshot shows the 'UV COVERAGE' software window. At the top, there are buttons for 'Close' and 'Help'. Below these are four buttons: 'CHANGE CATALOG', 'CHANGE INTERFEROMETER', 'VIEW CATALOG', and 'VIEW VLT2T Stations'. The 'Plot for Object:' field is set to 'R_SCL'. The 'Wavelength (microns)' is set to '10'. A yellow bar contains a dropdown menu with 'Push to validate Entries' and a 'PLOT UV COVERAGE' button. The main configuration area includes: 'Telescope #1 Name' (U1) and 'Telescope #2 Name' (U2) with dropdown menus; a checked 'RESET FRAME (start a new plot)' checkbox; 'Hour Angle Start' (-12.0) and 'Hour Angle End' (12.0) with sliders; 'Min. Elev. to Plot' (30.0) and 'Max. Elev. to Plot' (90.0) with sliders; 'U-V range to plot' (202.0) with a slider; 'U-V Integration Time (min)' (60); a checked 'Plot Aperture size on UV Plane' checkbox; 'Name of the output PSF UV Table' (oipt_psf) with a 'Browse...' button; 'Underplot a model image?' (unchecked) checkbox; 'This image filename...' (oipt_lastmodel.gdf) with a 'Browse...' button; 'Plot what...' (AMP) with a dropdown menu; and 'Use image-to-pixel conversion' (AUTOMATIC) with a dropdown menu. A bottom yellow bar contains a dropdown menu with 'Push to validate Entries' and a 'DISPLAY PSF' button.

UV COVERAGE

Close Help

CHANGE CATALOG CHANGE INTERFEROMETER VIEW CATALOG VIEW VLT2T Stations

Plot for Object: R_SCL

Wavelength (microns) 10

Push to validate Entries PLOT UV COVERAGE

Telescope #1 Name U1 U1

Telescope #2 Name U2 U2

RESET FRAME (start a new plot) ☒

Hour Angle Start -12.0

Hour Angle End 12.0

Min. Elev. to Plot 30.0

Max. Elev. to Plot 90.0

U-V range to plot 202.0

U-V Integration Time (min) 60

Plot Aperture size on UV Plane ☒

Name of the output PSF UV Table oipt_psf Browse...

Underplot a model image? ☐

This image filename... oipt_lastmodel.gdf Browse...

Plot what... AMP

Use image-to-pixel conversion AUTOMATIC

Push to validate Entries DISPLAY PSF

uv-coverage (part II)

UV COVERAGE

Close Help

CHANGE CATALOG CHANGE INTERFEROMETER VIEW CATALOG VIEW VLT2T Stations

Plot for Object: R_SCL

Wavelength (microns) 10

Push to validate Entries **PLOT UV COVERAGE**

Telescope #1 Name U1

Telescope #2 Name U2

RESET FRAME (start a new plot) ☒

Hour Angle Start -12.0

Hour Angle End 12.0

Min. Elev. to Plot 30.0

Max. Elev. to Plot 90.0

U-V range to plot 202.0

U-V Integration Time (min) 60

Plot Aperture size on UV Plane ☒

Name of the output PSF UV Table oipt_psf

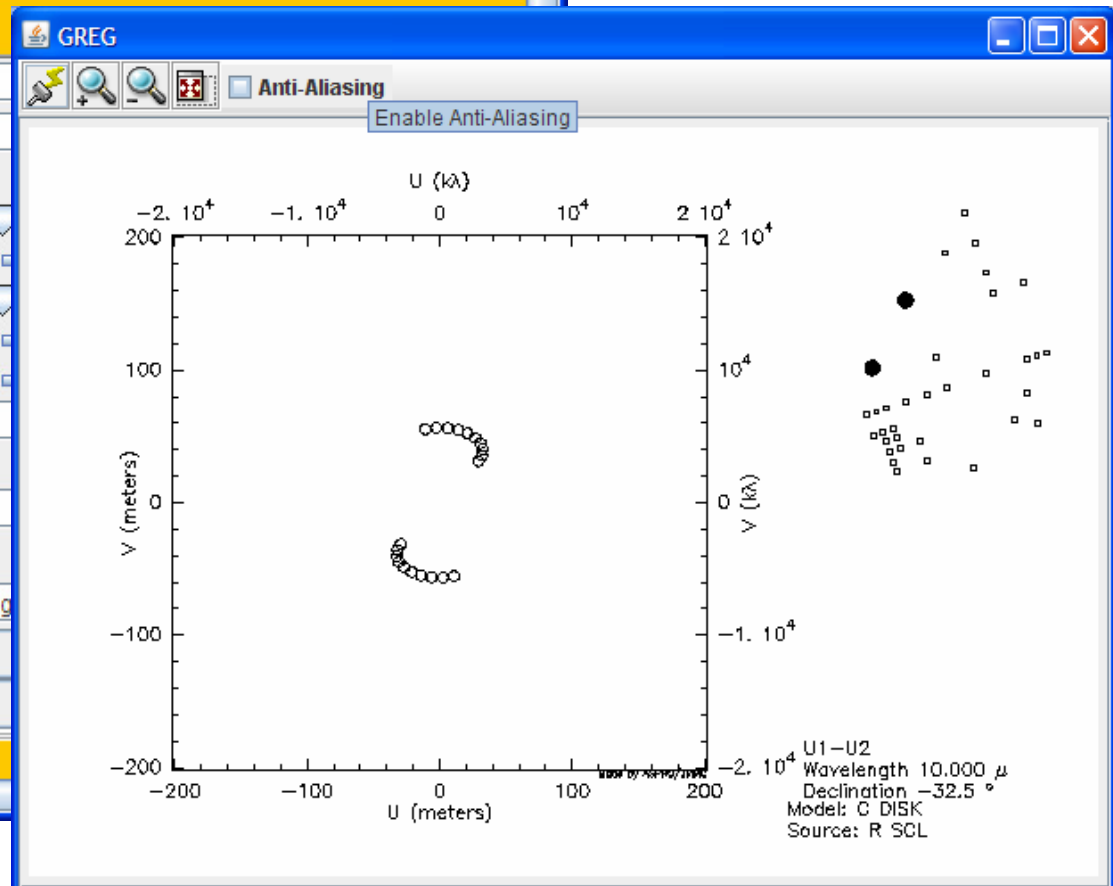
Underplot a model image? ☐

This image filename... oipt_lastmodel.g

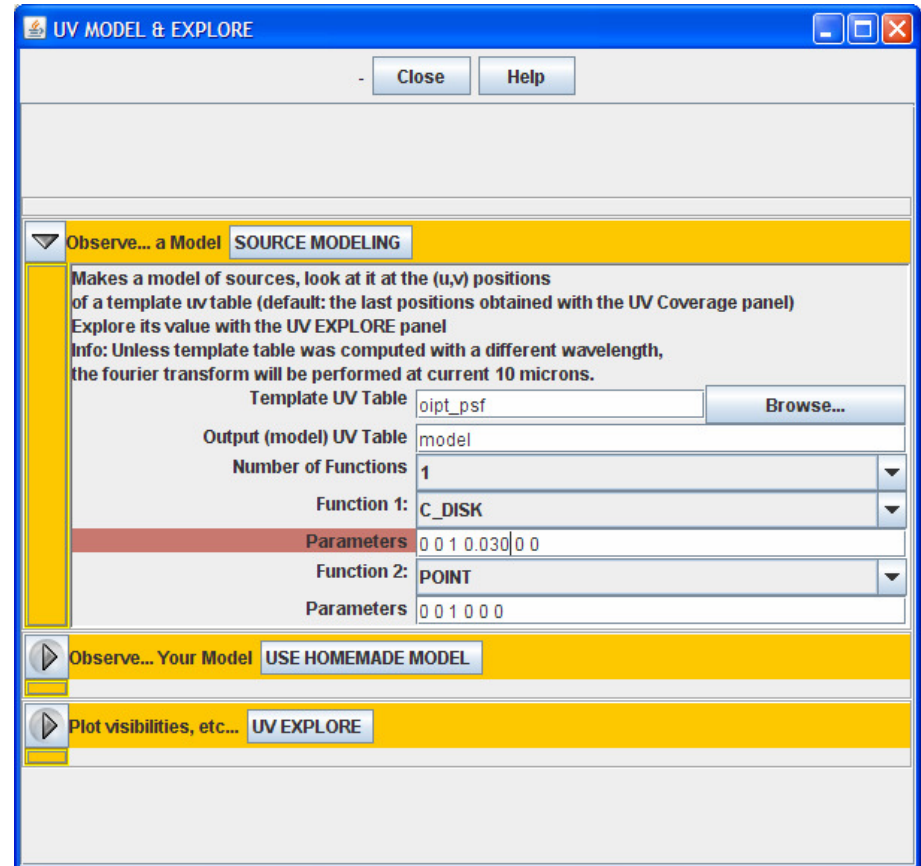
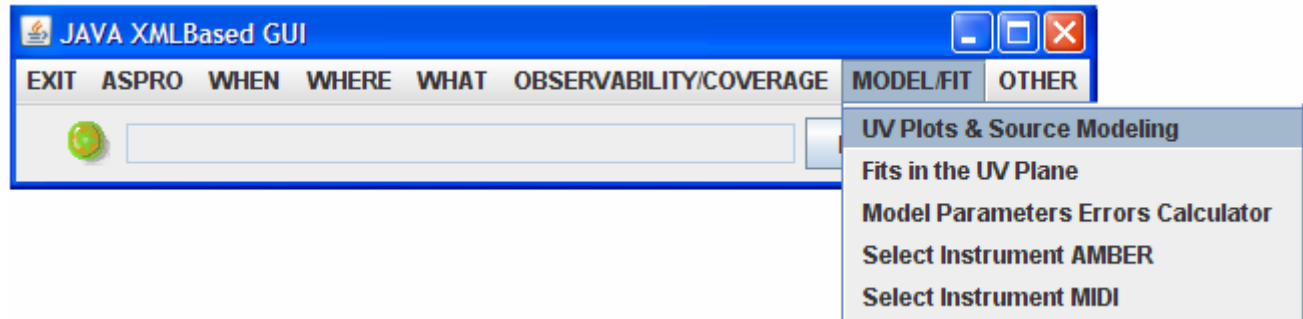
Plot what... AMP

Use image-to-pixel conversion AUTOMATIC

Push to validate Entries **DISPLAY PSF**



Model/Fit (part I)



Model/Fit (part I)

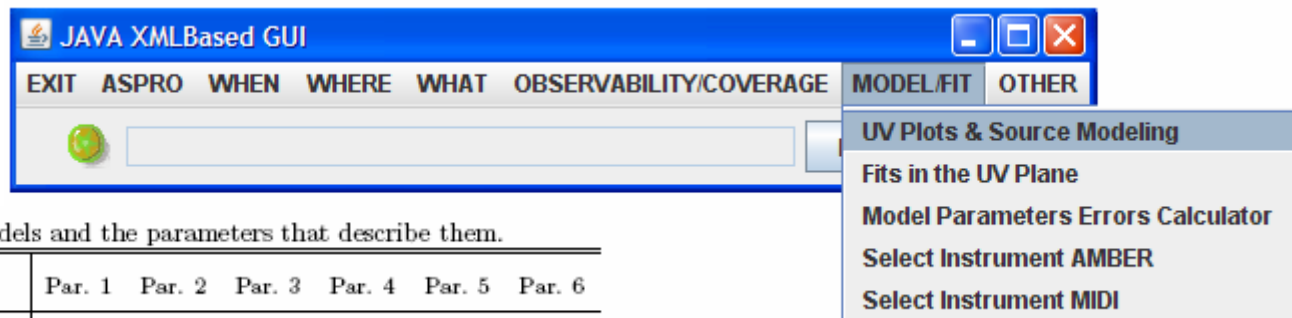
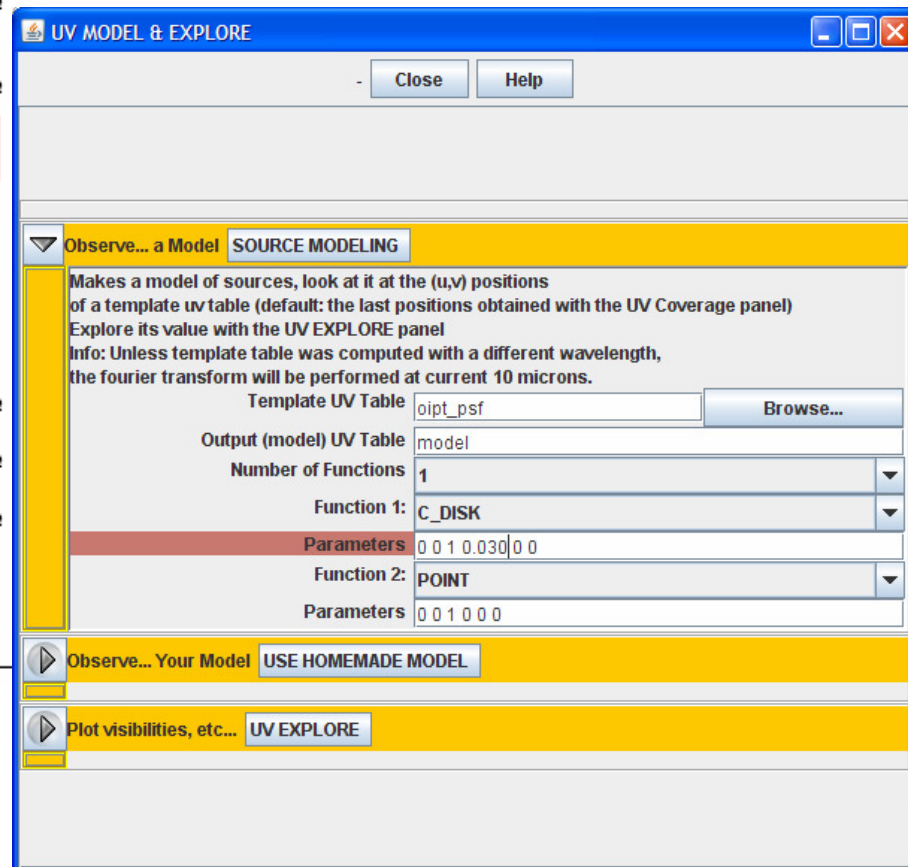


Table 1: List of available analytical models and the parameters that describe them.

| Name | Description | Par. 1 | Par. 2 | Par. 3 | Par. 4 | Par. 5 | Par. 6 |
|---------|---|----------------|----------------|---------|-------------|--------|--------|
| Point | Point Source (Dirac function) | $\Delta\alpha$ | $\Delta\delta$ | F_ν | - | - | - |
| C_Gauss | Circularly symmetric Gaussian distribution | $\Delta\alpha$ | $\Delta\delta$ | F_ν | $D^{1/2}$ | | |
| E_Gauss | Elliptical Gaussian distribution | $\Delta\alpha$ | $\Delta\delta$ | F_ν | $D_M^{1/2}$ | | |
| C_Disk | Circular disk (a.k.a. uniform disk) | $\Delta\alpha$ | $\Delta\delta$ | F_ν | D | | |
| E_Disk | Elliptical uniform disk (i.e., inclined C_Disk) | $\Delta\alpha$ | $\Delta\delta$ | F_ν | D_M | | |
| Ring | Uniform ring with finite width | $\Delta\alpha$ | $\Delta\delta$ | F_ν | D_t | | |
| U_Ring | Unresolved (infinitely narrow) ring | $\Delta\alpha$ | $\Delta\delta$ | F_ν | D | | |
| Exp | Exponential brightness distribution | $\Delta\alpha$ | $\Delta\delta$ | F_ν | $D^{1/2}$ | | |
| Power-2 | $1/r^2$ brightness distribution | $\Delta\alpha$ | $\Delta\delta$ | F_ν | $D^{1/2}$ | | |
| Power-3 | $1/r^3$ brightness distribution | $\Delta\alpha$ | $\Delta\delta$ | F_ν | $D^{1/2}$ | | |
| LD_Disk | Limb-darkened disk (resolved star) | $\Delta\alpha$ | $\Delta\delta$ | F_ν | D | | |
| Binary | Binary point source | $\Delta\alpha$ | $\Delta\delta$ | F_ν | FR | | |



Model/Fit (part II)

UV MODEL & EXPLORE

Close Help

Observe... a Model SOURCE MODELING

Observe... Your Model USE HOMEMADE MODEL

Plot visibilities, etc... UV EXPLORE

UV Table Name to Explore model

Y data V

X data U

Plot Model Curve(s) ☒

Add ErrorBars To Plot ☐

Plot limits (4 reals, all zeroes: auto) 0 1 0 0 1 0 0 0 0

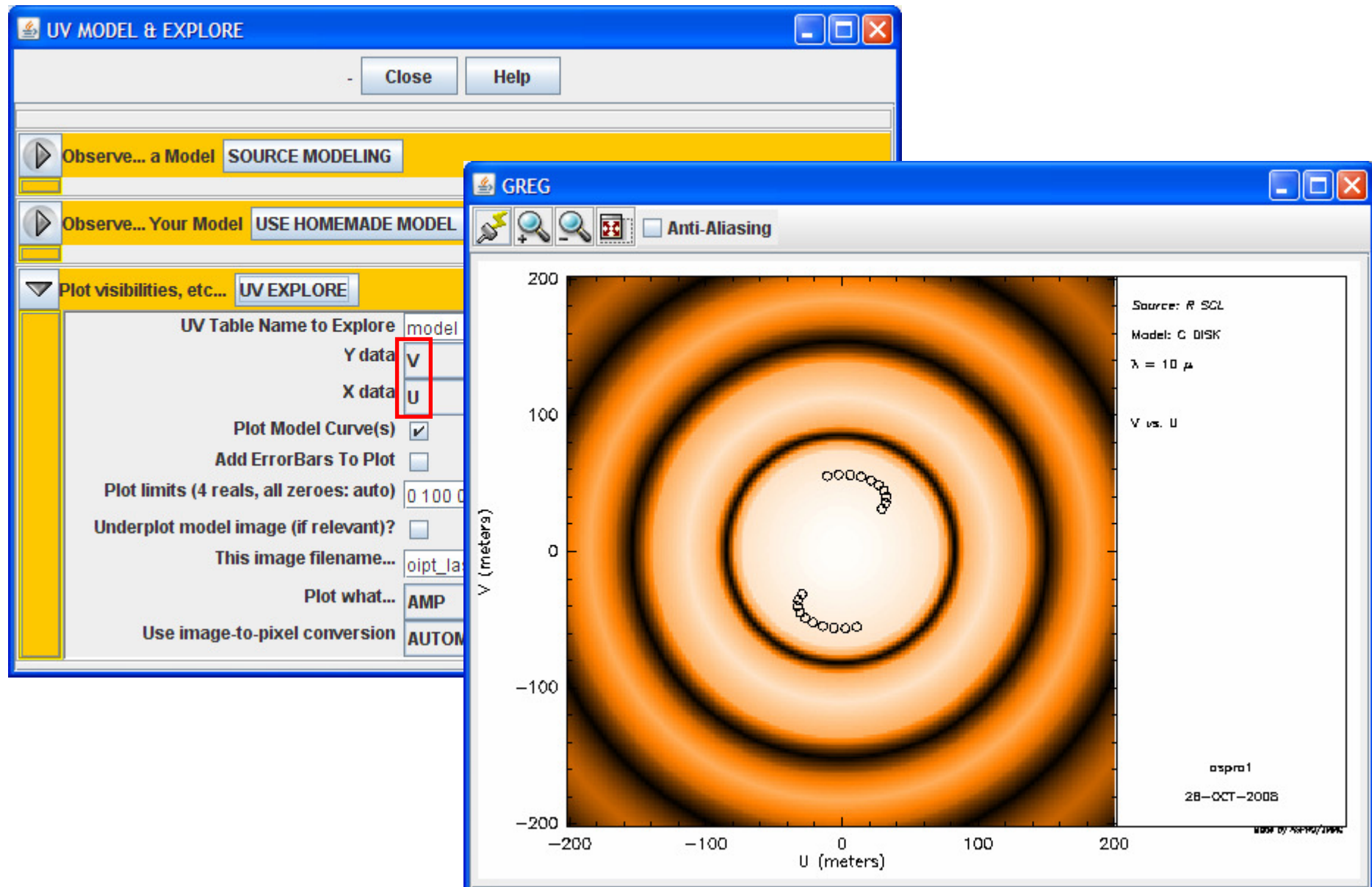
Underplot model image (if relevant)? ☐

This image filename... oipt_lastmodel.gdf Browse...

Plot what... AMP

Use image-to-pixel conversion AUTOMATIC

Model/Fit (part II)



Model/Fit (part III)

UV MODEL & EXPLORE

Close Help

Observe... a Model SOURCE MODELING

Observe... Your Model USE HOMEMADE MODEL

Plot visibilities, etc... UV EXPLORE

UV Table Name to Explore model

Y data AMP

X data RADIUS

Plot Model Curve(s) ☒

Add ErrorBars To Plot ☐

Plot limits (4 reals, all zeroes: auto) 0 1 0 0 1 0 0 0 0

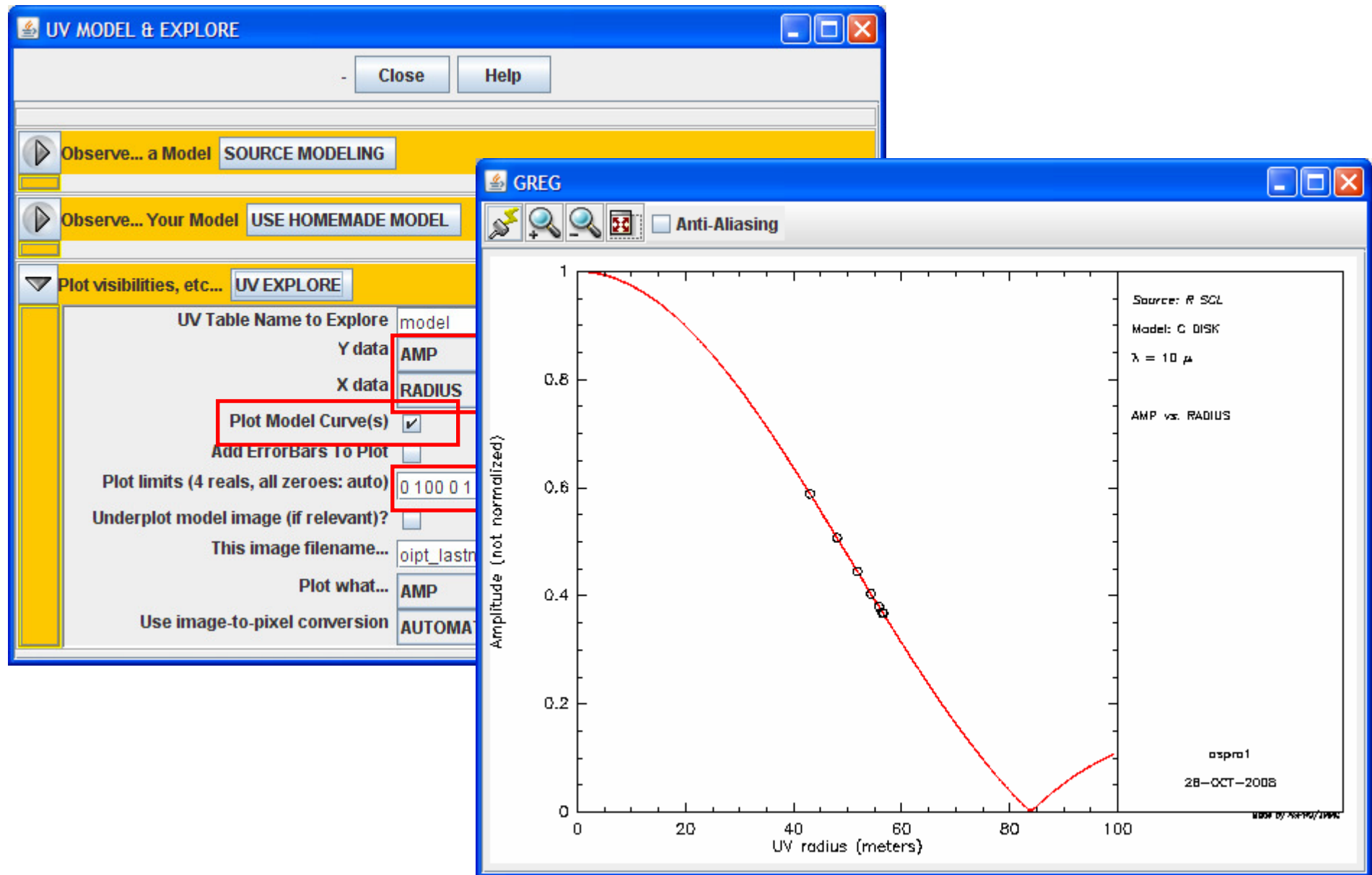
Underplot model image (if relevant)? ☐

This image filename... oipt_lastmodel.gdf Browse...

Plot what... AMP

Use image-to-pixel conversion AUTOMATIC

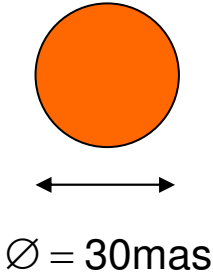
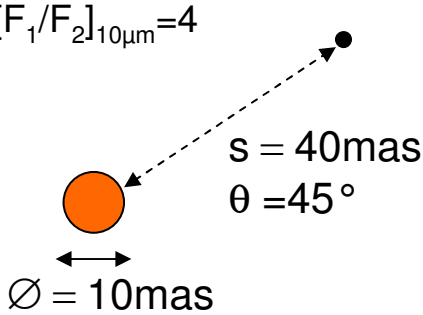
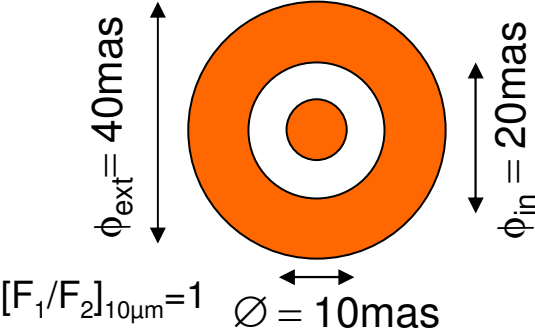
Model/Fit (part III)



Model/Fit (part IV)

DIRECT

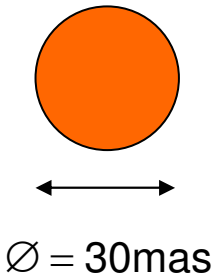
FOURIER SPACE

| | Uniform disk | Resolved binary | Uniform disk + Uniform ring |
|--|--|---|--|
| |  <p>$\varnothing = 30\text{mas}$</p> |  <p>$[F_1/F_2]_{10\mu\text{m}}=4$ $s = 40\text{mas}$ $\theta = 45^\circ$ $\varnothing = 10\text{mas}$</p> |  <p>$\phi_{\text{ext}} = 40\text{mas}$ $\phi_{\text{in}} = 20\text{mas}$ $[F_1/F_2]_{10\mu\text{m}}=1$ $\varnothing = 10\text{mas}$</p> |
| | | | |
| | | | |

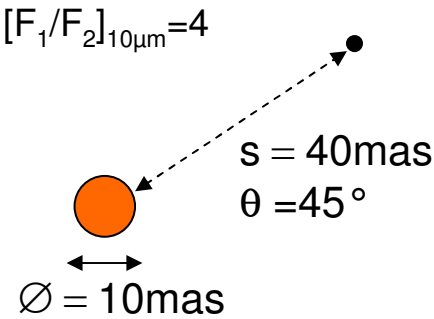
Model/Fit (part IV)

DIRECT

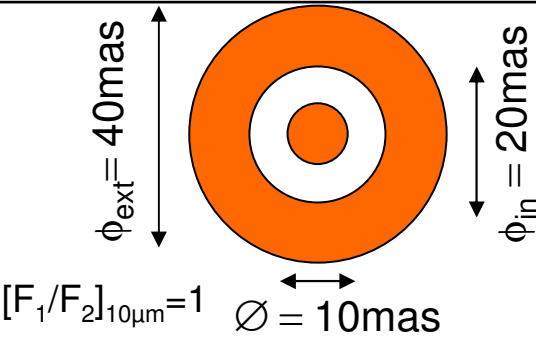
Uniform disk



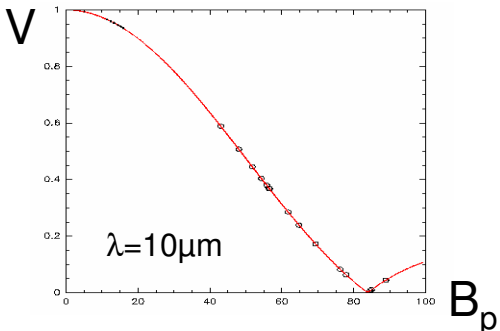
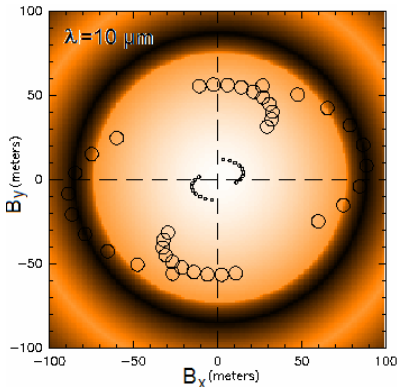
Resolved binary



Uniform disk +
Uniform ring



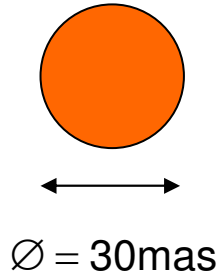
FOURIER
SPACE



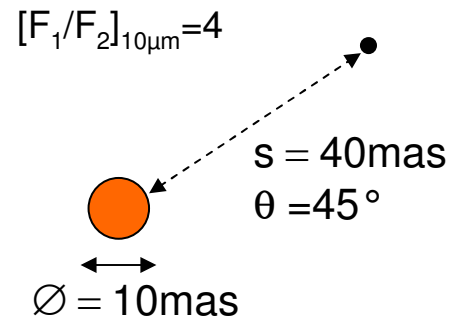
Model/Fit (part IV)

DIRECT

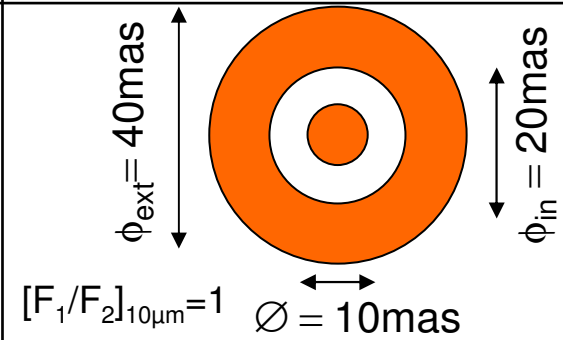
Uniform disk



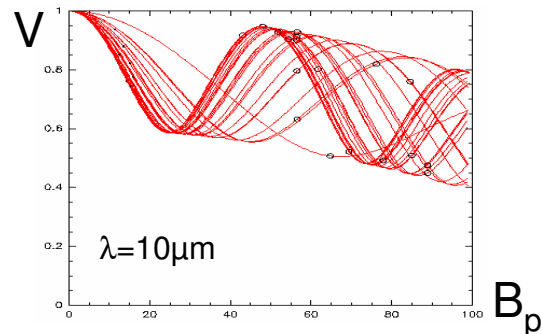
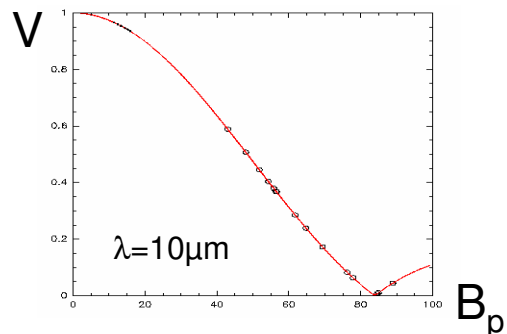
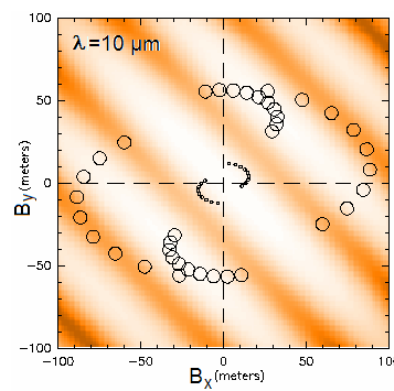
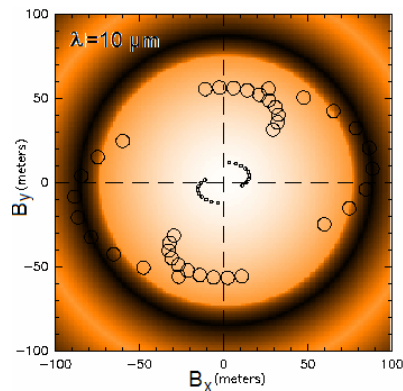
Resolved binary



Uniform disk +
Uniform ring



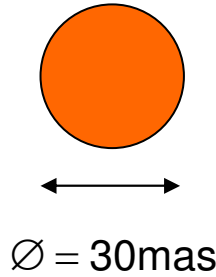
FOURIER
SPACE



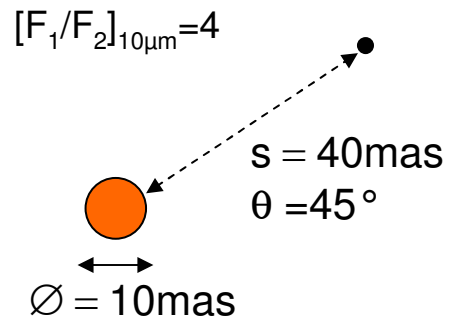
Model/Fit (part IV)

DIRECT

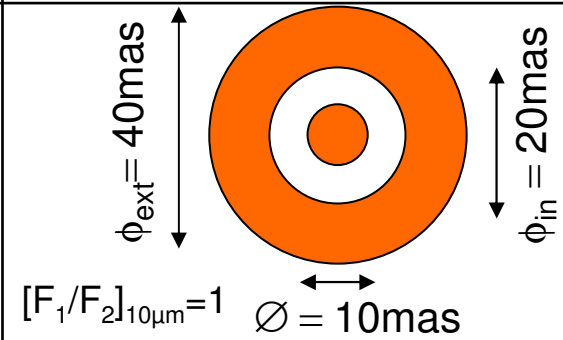
Uniform disk



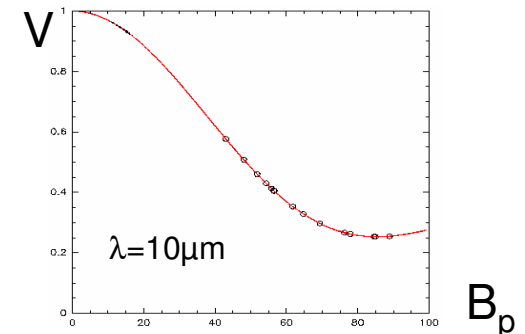
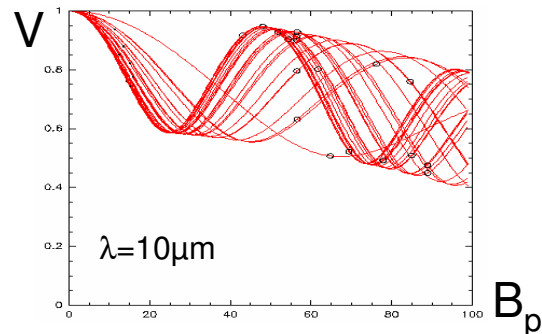
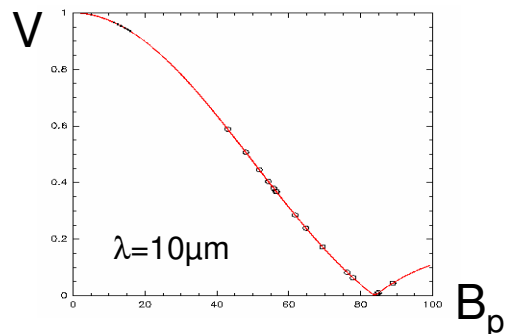
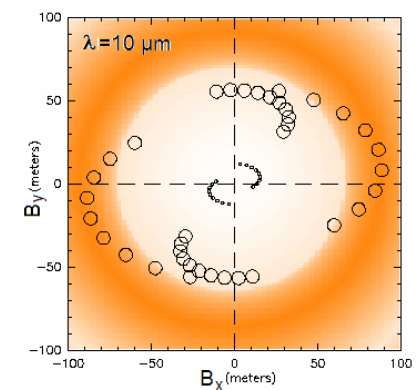
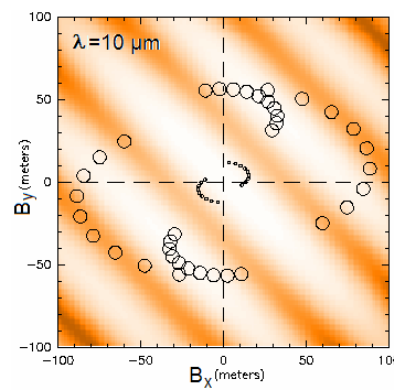
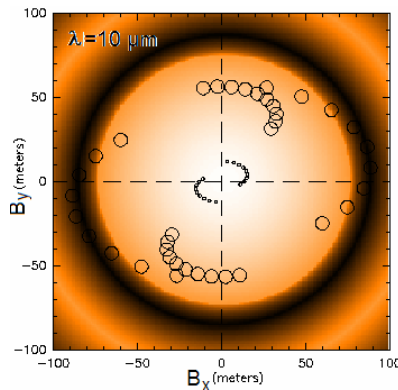
Resolved binary



Uniform disk +
Uniform ring



FOURIER SPACE



DEFINE THE BEST CALIBRATOR

http://www.jmmc.fr/searchcal_page.htm

How to launch SearchCal in the web?



JEAN-MARIE MARIOTTI CENTER
Infrared and Optical Interferometry for Astronomy

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Who are we ?
Who was JMM ?
Partners
Structure
Working groups

EII - JRA4
Training
Proposal preparation
ASPRO
SearchCal
VLTi proposals


Data processing
VINCI
MIDI
AMBER

SearchCal: the JMMC Evolutive Search Calibrator Tool

 [subscribe to SearchCal feed](#)

SearchCal is a tool developed by the JMMC Working Group "catalogue of calibration sources" to assist the astronomers in this calibrator selection process for long baseline interferometric observations.

Scientific and technical background of SearchCal are described in the paper
Bonneau D., Clausse J.-M., Delfosse X., et al., 2006, A&A 456, 789.


[Download Application](#)




[Installation Help](#)

You can access the online user manual (from *Help* menu) or download it in pdf format.

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

1) Instrumental Configuration

Magnitude Band : **V** ▼
Wavelength (V) [μm] : 0.55
Max. Baseline [m] : 102.45

2) Science Object

Name : **Q** ETA_TAU
RA 2000 [hh:mm:ss] : 03:47:29.0765
DEC 2000 [+/-dd:mm:ss] : 24:06:18.494
Magnitude (V) : 0.0

3) SearchCal Parameters

Min. Magnitude (V) : -2.0
Max. Magnitude (V) : 2.0
Scenario : ☒ Bright ☐ Faint
RA Range [mn] : 240.0
DEC Range [deg] : 20.0

Progress :

Get Calibrators

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

| | | |
|---|--|--|
| 1) Instrumental Configuration | 2) Science Object | 3) SearchCal Parameters |
| Magnitude Band : V | Name : <input type="text" value="Q ETA_TAU"/> | Min. Magnitude (V) : <input type="text" value="-2.0"/> |
| Wavelength (V) [μ m] : <input type="text" value="0.55"/> | RA 2000 [hh:mm:ss] : <input type="text" value="03:47:29.0765"/> | Max. Magnitude (V) : <input type="text" value="2.0"/> |
| Max. Baseline [m] : <input type="text" value="102.45"/> | DEC 2000 [+/-dd:mm:ss] : <input type="text" value="24:06:18.494"/> | Scenario : <input checked="" type="radio"/> Bright <input type="radio"/> Faint |
| | Magnitude (V) : <input type="text" value="0.0"/> | RA Range [mn] : <input type="text" value="240.0"/> |
| | | DEC Range [deg] : <input type="text" value="20.0"/> |

Progress :

- ❖ Choose your observing wavelength (AMBER-H/K or MIDI-N)

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

| | | |
|--|---|---|
| 1) Instrumental Configuration | 2) Science Object | 3) SearchCal Parameters |
| Magnitude Band: V | Name: <input type="text" value="Q ETA_TAU"/> | Min. Magnitude (V): <input type="text" value="-2.0"/> |
| Wavelength (V) [μm]: <input type="text" value="0.55"/> | RA 2000 [hh:mm:ss]: <input type="text" value="03:47:29.0765"/> | Max. Magnitude (V): <input type="text" value="2.0"/> |
| Max. Baseline [m]: <input type="text" value="102.45"/> | DEC 2000 [+/-dd:mm:ss]: <input type="text" value="24:06:18.494"/> | Scenario: <input checked="" type="radio"/> Bright <input type="radio"/> Faint |
| | Magnitude (V): <input type="text" value="0.0"/> | RA Range [mn]: <input type="text" value="240.0"/> |
| | | DEC Range [deg]: <input type="text" value="20.0"/> |

Progress:

- ❖ Choose your observing wavelength (AMBER-H/K or MIDI-N)
- ❖ The maximum baseline of your observation (*limit of sensitivity*)

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

| 1) Instrumental Configuration | 2) Science Object | 3) SearchCal Parameters |
|-------------------------------|--------------------------------------|---|
| Magnitude Band: V | Name: ETA_TAU | Min. Magnitude (V): -2.0 |
| Wavelength (V) [μm]: 0.55 | RA 2000 [hh:mm:ss]: 03:47:29.0765 | Max. Magnitude (V): 2.0 |
| Max. Baseline [m]: 102.45 | DEC 2000 [+/-dd:mm:ss]: 24:06:18.494 | Scenario: <input checked="" type="radio"/> Bright <input type="radio"/> Faint |
| | Magnitude (V): 0.0 | RA Range [mn]: 240.0 |
| | | DEC Range [deg]: 20.0 |

Progress:

- ❖ Choose your observing wavelength (AMBER-H/K or MIDI-N)
- ❖ The maximum baseline of your observation (*limit of sensitivity*)
- ❖ The science target

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

| 1) Instrumental Configuration | 2) Science Object | 3) SearchCal Parameters |
|----------------------------------|--------------------------------------|---|
| Magnitude Band: V | Name: ETA_TAU | Min. Magnitude (V): -2.0 |
| Wavelength (V) [μm]: 0.55 | RA 2000 [hh:mm:ss]: 03:47:29.0765 | Max. Magnitude (V): 2.0 |
| Max. Baseline [m]: 102.45 | DEC 2000 [+/-dd:mm:ss]: 24:06:18.494 | Scenario: <input checked="" type="radio"/> Bright <input type="radio"/> Faint |
| | Magnitude (V): 0.0 | RA Range [mn]: 240.0 |
| | | DEC Range [deg]: 20.0 |

Progress:

- ❖ Choose your observing wavelength (AMBER-H/K or MIDI-N)
- ❖ The maximum baseline of your observation (*limit of sensitivity*)
- ❖ The science target
- ❖ The maximum location around the science target (*close enough to avoid atmospheric biases*)

CALIBRATORS

File Edit Query Calibrators Interop Help

Query Parameters

| 1) Instrumental Configuration | 2) Science Object | 3) SearchCal Parameters |
|--------------------------------|--------------------------------------|---|
| Magnitude Band: V | Name: ETA_TAU | Min. Magnitude (V): -2.0 |
| Wavelength (V) [μm]: 0.55 | RA 2000 [hh:mm:ss]: 03:47:29.0765 | Max. Magnitude (V): 2.0 |
| Max. Baseline [m]: 102.45 | DEC 2000 [+/-dd:mm:ss]: 24:06:18.494 | Scenario: <input checked="" type="radio"/> Bright <input type="radio"/> Faint |
| | Magnitude (V): 0.0 | RA Range [mn]: 240.0 |
| | | DEC Range [deg]: 20.0 |
| Progress: <input type="text"/> | | Get Calibrators |

- ❖ Choose your observing wavelength (AMBER-H/K or MIDI-N)
- ❖ The maximum baseline of your observation (*limit of sensitivity*)
- ❖ The science target
- ❖ The maximum location around the science target (*close enough to avoid atmospheric biases*)
- ❖ And get your calibrators (*from the various catalogs existing*)

Table

| Index | dist | HD | RAJ2000 | DEJ2000 | vis2 | vis2Err |
|-------|--------|-----------------------|--------------|--------------|-------|---------|
| 1 | 0.0 | 23630 | 03 47 29.076 | +24 06 18.48 | 0.892 | 0.014 |
| 2 | 0.46 | 23408 | 03 45 49.607 | +24 22 03.89 | 0.978 | 0.0030 |
| 3 | 4.445 | 25604 | 04 04 41.715 | +22 04 54.93 | 0.612 | 0.043 |
| 4 | 6.745 | 26162 | 04 09 09.966 | +19 36 33.18 | 0.847 | 0.02 |
| 5 | 8.08 | 27382 | 04 20 21.216 | +27 21 02.71 | 0.667 | 0.039 |
| 6 | 8.266 | 27482 | 04 21 15.258 | +27 21 00.89 | 0.522 | 0.01 |
| 7 | 8.807 | 19637 | 03 10 27.046 | +26 53 46.44 | 0.806 | 0.0050 |
| 8 | 8.89 | 27934 | 04 25 22.166 | +22 17 37.94 | 0.973 | 0.0040 |
| 9 | 8.995 | 28024 | 04 26 18.464 | +22 48 48.89 | 0.95 | 0.0070 |
| 10 | 9.049 | 21110 | 03 25 23.920 | +31 43 51.95 | 0.874 | 0.016 |
| 11 | 9.395 | 19787 | 03 11 37.764 | +19 43 36.03 | 0.657 | 0.039 |
| 12 | 10.118 | 26526 | 04 12 58.443 | +32 31 57.82 | 0.646 | 0.01 |
| 13 | 10.535 | 19460 | 03 08 21.109 | +18 47 42.19 | 0.627 | 0.0060 |
| 14 | 10.782 | 26311 | 04 10 59.020 | +33 35 12.44 | 0.678 | 0.0070 |
| 15 | 13.153 | 28100 | 04 26 36.373 | +14 42 49.62 | 0.72 | 0.034 |
| 16 | 14.253 | 17361 | 02 47 54.541 | +29 14 49.63 | 0.61 | 0.01 |
| 17 | 15.476 | 30454 | 04 49 12.847 | +31 26 14.55 | 0.692 | 0.036 |
| 18 | 16.048 | 31553 | 04 57 48.647 | +23 56 54.80 | 0.814 | 0.024 |
| 19 | 19.234 | 15176 | 02 27 27.772 | +31 48 04.61 | 0.823 | 0.0040 |

Table

| Index | dist | HD | RAJ2000 | DEJ2000 | vis2 | vis2Err |
|-------|--------|-----------------------|--------------|--------------|-------|---------|
| 1 | 0.0 | 23630 | 03 47 29.076 | +24 06 18.48 | 0.892 | 0.014 |
| 2 | 0.46 | 23408 | 03 45 49.607 | +24 22 03.89 | 0.978 | 0.0030 |
| 3 | 4.445 | 25604 | 04 04 41.715 | +22 04 54.93 | 0.612 | 0.043 |
| 4 | 6.745 | 26162 | 04 09 09.966 | +19 36 33.18 | 0.847 | 0.02 |
| 5 | 8.08 | 27382 | 04 20 21.216 | +27 21 02.71 | 0.667 | 0.039 |
| 6 | 8.266 | 27482 | 04 21 15.258 | +27 21 00.89 | 0.522 | 0.01 |
| 7 | 8.807 | 19637 | 03 10 27.046 | +26 53 46.44 | 0.806 | 0.0050 |
| 8 | 8.89 | 27934 | 04 25 22.166 | +22 17 37.94 | 0.973 | 0.0040 |
| 9 | 8.995 | 28024 | 04 26 18.464 | +22 48 48.89 | 0.95 | 0.0070 |
| 10 | 9.049 | 21110 | 03 25 23.920 | +31 43 51.95 | 0.874 | 0.016 |
| 11 | 9.395 | 19787 | 03 11 37.764 | +19 43 36.03 | 0.657 | 0.039 |
| 12 | 10.118 | 26526 | 04 12 58.443 | +32 31 57.82 | 0.646 | 0.01 |
| 13 | 10.535 | 19460 | 03 08 21.109 | +18 47 42.19 | 0.627 | 0.0060 |
| 14 | 10.782 | 26311 | 04 10 59.020 | +33 35 12.44 | 0.678 | 0.0070 |
| 15 | 13.153 | 28100 | 04 26 36.373 | +14 42 49.62 | 0.72 | 0.034 |
| 16 | 14.253 | 17361 | 02 47 54.541 | +29 14 49.63 | 0.61 | 0.01 |
| 17 | 15.476 | 30454 | 04 49 12.847 | +31 26 14.55 | 0.692 | 0.036 |
| 18 | 16.048 | 31553 | 04 57 48.647 | +23 56 54.80 | 0.814 | 0.024 |
| 19 | 19.234 | 15176 | 02 27 27.772 | +31 48 04.61 | 0.823 | 0.0040 |

❖ Separation from the science target in degree

Table

| Index | dist | HD | RAJ2000 | DEJ2000 | vis2 | vis2Err |
|-------|--------|-----------------------|--------------|--------------|-------|---------|
| 1 | 0.0 | 23630 | 03 47 29.076 | +24 06 18.48 | 0.892 | 0.014 |
| 2 | 0.46 | 23408 | 03 45 49.607 | +24 22 03.89 | 0.978 | 0.0030 |
| 3 | 4.445 | 25604 | 04 04 41.715 | +22 04 54.93 | 0.612 | 0.043 |
| 4 | 6.745 | 26162 | 04 09 09.966 | +19 36 33.18 | 0.847 | 0.02 |
| 5 | 8.08 | 27382 | 04 20 21.216 | +27 21 02.71 | 0.667 | 0.039 |
| 6 | 8.266 | 27482 | 04 21 15.258 | +27 21 00.89 | 0.522 | 0.01 |
| 7 | 8.807 | 19637 | 03 10 27.046 | +26 53 46.44 | 0.806 | 0.0050 |
| 8 | 8.89 | 27934 | 04 25 22.166 | +22 17 37.94 | 0.973 | 0.0040 |
| 9 | 8.995 | 28024 | 04 26 18.464 | +22 48 48.89 | 0.95 | 0.0070 |
| 10 | 9.049 | 21110 | 03 25 23.920 | +31 43 51.95 | 0.874 | 0.016 |
| 11 | 9.395 | 19787 | 03 11 37.764 | +19 43 36.03 | 0.657 | 0.039 |
| 12 | 10.118 | 26526 | 04 12 58.443 | +32 31 57.82 | 0.646 | 0.01 |
| 13 | 10.535 | 19460 | 03 08 21.109 | +18 47 42.19 | 0.627 | 0.0060 |
| 14 | 10.782 | 26311 | 04 10 59.020 | +33 35 12.44 | 0.678 | 0.0070 |
| 15 | 13.153 | 28100 | 04 26 36.373 | +14 42 49.62 | 0.72 | 0.034 |
| 16 | 14.253 | 17361 | 02 47 54.541 | +29 14 49.63 | 0.61 | 0.01 |
| 17 | 15.476 | 30454 | 04 49 12.847 | +31 26 14.55 | 0.692 | 0.036 |
| 18 | 16.048 | 31553 | 04 57 48.647 | +23 56 54.80 | 0.814 | 0.024 |
| 19 | 19.234 | 15176 | 02 27 27.772 | +31 48 04.61 | 0.823 | 0.0040 |

- ❖ Separation from the science target in degree
- ❖ Evaluation of the corresponding equivalent UD visibility value

Selection criteria

Filters

| | | | | |
|--|--|------|-----------------------------------|------|
| <input type="checkbox"/> Reject stars farther than : | Maximum RA Separation (mn) : | 10.0 | Maximum DEC Separation (degree) : | 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : | 1.5 | | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | | | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | | | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | | | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | | | |
| <input type="checkbox"/> Reject Variability | | | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | | | |

Selection criteria

| Filters | |
|--|--|
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : 10.0 Maximum DEC Separation (degree) : 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : 1.5 |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI |
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| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 |
| <input type="checkbox"/> Reject Variability | |
| <input checked="" type="checkbox"/> Reject Multiplicity | |

❖ location of the calibrator (*as close as possible*)

Selection criteria

| | | | | |
|--|--|------|-----------------------------------|------|
| Filters | | | | |
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : | 10.0 | Maximum DEC Separation (degree) : | 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : | 1.5 | | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | | | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | | | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | | | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | | | |
| <input type="checkbox"/> Reject Variability | | | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | | | |

- ❖ location of the calibrator (*as close as possible*)
- ❖ brightness (*as bright as possible to get a high Signal to Noise ratio*)

Selection criteria

Filters

| | | |
|--|--|--|
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : 10.0 | Maximum DEC Separation (degree) : 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : 1.5 | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | |
| <input type="checkbox"/> Reject Variability | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | |

- ❖ location of the calibrator (*as close as possible*)
- ❖ brightness (*as bright as possible to get a high Signal to Noise ratio*)
- ❖ spectral type and luminosity (*avoid complex object like cool stars*)

Selection criteria

Filters

| | | |
|--|--|--|
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : 10.0 | Maximum DEC Separation (degree) : 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : 1.5 | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | |
| <input type="checkbox"/> Reject Variability | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | |

- ❖ location of the calibrator (*as close as possible*)
- ❖ brightness (*as bright as possible to get a high Signal to Noise ratio*)
- ❖ spectral type and luminosity (*avoid complex object like cool stars*)
- ❖ visibility and accuracy (*avoid too large objects -> V small -> poor S/N ratio*)

Selection criteria

Filters

| | | |
|--|--|--|
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : 10.0 | Maximum DEC Separation (degree) : 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : 1.5 | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | |
| <input type="checkbox"/> Reject Variability | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | |

- ❖ location of the calibrator (*as close as possible*)
- ❖ brightness (*as bright as possible to get a high Signal to Noise ratio*)
- ❖ spectral type and luminosity (*avoid complex object like cool stars*)
- ❖ visibility and accuracy (*avoid too large objects -> V small -> poor S/N ratio*)
- ❖ variability (*avoid to use variable objects that may lead to temporal biases in the calibrated measurements*)

Selection criteria

Filters

| | | |
|--|--|--|
| <input type="checkbox"/> Reject stars farther than | Maximum RA Separation (mn) : 10.0 | Maximum DEC Separation (degree) : 10.0 |
| <input type="checkbox"/> Reject stars with magnitude above : | Magnitude : 1.5 | |
| <input type="checkbox"/> Reject Spectral Types (and unknowns) : | <input type="checkbox"/> O <input type="checkbox"/> B <input type="checkbox"/> A <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/> K <input type="checkbox"/> M | |
| <input type="checkbox"/> Reject Luminosity Classes (and unknowns) : | <input type="checkbox"/> I <input type="checkbox"/> II <input type="checkbox"/> III <input type="checkbox"/> IV <input type="checkbox"/> V <input type="checkbox"/> VI | |
| <input checked="" type="checkbox"/> Reject Visibility below : | vis2 : 0.5 | |
| <input type="checkbox"/> Reject Visibility Accuracy above (or unknown) : | vis2Err/vis2 (%) : 2.0 | |
| <input type="checkbox"/> Reject Variability | | |
| <input checked="" type="checkbox"/> Reject Multiplicity | | |

- ❖ location of the calibrator (*as close as possible*)
- ❖ brightness (*as bright as possible to get a high Signal to Noise ratio*)
- ❖ spectral type and luminosity (*avoid complex object like cool stars*)
- ❖ visibility and accuracy (*avoid too large objects -> V small -> poor S/N ratio*)
- ❖ variability (*avoid to use variable objects that may lead to temporal biases in the calibrated measurements*)
- ❖ multiplicity (*avoid multiple object that may lead to a wrong interpretation of the calibrated measurements*)

DEFINE THE BEST CALIBRATOR

Found Calibrators (63 sources, 61 filtered)

| Index | dist | HD | RAJ2000 | DEJ2000 | vis2 | vis2Err | diam_vk | e_diam_vk | UD_V | U |
|-------|--------|-----------------------|--------------|--------------|-------|---------|---------|-----------|-------|-------|
| 1 | 0.0 | 23630 | 03 47 29.076 | +24 06 18.48 | 0.892 | 0.014 | 0.947 | 0.065 | 0.914 | 0.933 |
| 2 | 22.544 | 35497 | 05 26 17.513 | +28 36 26.82 | 0.893 | 0.014 | 0.946 | 0.065 | 0.913 | 0.932 |

HD35497

Filters

☒ Reject stars farther than : Maximum RA Separation (mn) : 100.0 Maximum DEC Separation (degree) : 5.0

☒ Reject stars with magnitude above : Magnitude : 2.5

☒ Reject Spectral Types (and unknowns) : ☐ O ☐ B ☐ A ☐ F ☐ G ☐ K ☐ M

☒ Reject Luminosity Classes (and unknowns) : ☐ I ☐ II ☐ III ☐ IV ☐ V ☐ VI

☒ Reject Visibility below : vis2 : 0.7

☒ Reject Visibility Accuracy above (or unknown) : vis2Err/vis2 (%) : 2.0

☒ Reject Variability

☒ Reject Multiplicity