

**Observational Astrophysics II**  
**Interferometric Practice Work Session 2**  
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**From models to visibilities**

ASPRO:

[http://www.jmmc.fr/aspro\\_page.htm](http://www.jmmc.fr/aspro_page.htm)

The user manual for ASPRO can be retrieved at the following link:

<http://www.jmmc.fr/doc/approved/JMMC-MAN-2100-0002.pdf>

The following exercises aimed at getting trained to the link between the object intensity distribution and the corresponding visibility curves. This practical session is meant to be done with the MODEL/FIT part of the ASPRO software.

I. Setting up the observations

- Chose the Full Aspro Interface
- In the WHEN menu (*Date & Time Setup*) choose the date of 15-APR-2012 and Click Go.
- In the WHERE menu, select *VLT, 2 Telescopes*

**Ex.1 Determination of the angular radius of a star using a Uniform Disk model.**

Here you will prepare the observation of HD 68273 (hd\_68273).

- i. First, try to figure out when this star is observable and choose the best time to get the full observability of the object.

In the following, you will define an optimal array configuration to determine the radius of the targets with the highest accessible accuracy. The observing wavelength will be the K-band.

Table 1. Star main characteristics:

Object	Spectral Type	$\alpha$	$\delta$	Diameter (mas) (Parameter 4)
HD 68273	K2III	08:09:31.95	-47:20:11.7	2

Go to the OBSERVABILITY/COVERAGE menu and choose the E0-G0 configuration. Click now on the *UV coverage and PSF* and set the *wavelength (in microns)*. Then click on the arrow close to the *Push to validate entry* and select 60min in the *U-V Integration Time*. Have a look to the *uv* coverage you get by clicking on *PLOT UV COVERAGE*.

Go now to the MODEL/FIT menu and select the *UV plots and Source modeling* item. Click on the arrow close to SOURCE MODELING set the item *Number of functions* to 1 and choose the corresponding Uniform Disk (C\_Disk) function. Set the angular diameter of the UD to 2 mas = 0.002 arcsec (Parameter 4 “in *arcsec*”; cf the parametric table) and Click on the SOURCE MODELING button.

Go now on the *UV EXPLORE* and choose in the *Y data* box *AMP* (which gives you the visibility amplitude of your object) and in the *X data* box *RADIUS* (which corresponds to the projected baseline of the related configuration).

Select *Plot Model Curve* and push the *UV EXPLORE* button. Set the plot range with the *Plot Limits* box [ $x_{min}=0, x_{max}=40, y_{min}=0, y_{max}=1$ ].

- ii. What do you conclude about the baseline length?

Coming back to the UV-Coverage and PSF, repeat the process changing the configuration to A0-G1.

- iii. Which configuration would be the more appropriate to constrain the diameter of the UD model and why? What are your conclusions?
- iv. At which baseline does the visibility become equal to zero? Use this number to re-evaluate the disk diameter. (Remember the formula  $J_1(X)/(X)=0$  when  $X \sim 3.8317$  where  $X = \pi \cdot \theta \cdot B / \lambda$ ).

## Ex.2 Unresolved binary parameters determination

In fact a “mistake” was introduced: the star HD 68273 is known to be a binary star. Let us consider now that star has a close binary companion with the properties summarized in Table 2.

Table 2. Binary system characteristics:

Flux ratio $\Delta\text{mag}$ (Parameter 4)	Separation $\rho$ (mas) (Parameter 5)	Position angle PA ( $^\circ$ ) (Parameter 6)
0.5	3	105

Select the baseline U1-U2. Return to the *UV EXPLORE* part and plot the visibility of the model as a function of the projected baseline (*X data* box *RADIUS*).

- i. Why is there more than one visibility profile plotted in comparison to the Uniform Disk model?

Now, plot the visibility of the model as a function of the projected angle (*X data* box *ANGLE*)

- ii. Does the visibility amplitude can constrain the binary nature of the system?

Set  $V$  in the *Y data* box and  $U$  in the *X data* box. This gives you the  $uv$  coverage of your observation superimposed on the Fourier transform of the binary model.

- iii. What can you say about the orientation of the projected baseline comparing to the orientation of the binary axis?
- iv. Considering the  $uv$  coverage given by this configuration, do you think that the parameter of flux ratio (i.e. related to the highest modulation amplitude of the curve) of both components can be recovered and why?
- v. Use the schematic view of the telescope positions to find a more appropriate baseline configuration allowing to get better constraints on the binary nature of the object.
- vi. From the previous considerations, can you now recover the flux ratio of the binary system?

### Ex.3 Elliptical Disk

Come back to the U1-U2 configuration and display the visibility curve of a uniform disk which is assumed to have an elliptical shape (E\_DISK). Use a minor and major axis values (Parameters 4 & 5; cf parametric table) of 6 and 10 mas respectively, to simulate the inclination of the disk and fix the position angle (Parameter 6) to  $30^\circ$ .

- vii. Can you find the best configuration to constrain the size of the minor axis of the disk?
- viii. Could you derive the angular size of this axis from the first-zero visibility you get from this configuration?

### Ex.4 Double-component model

Construct a 2-component model (*Number of functions* 2) in which a central resolved star (UD) of diameter 4mas is surrounded by an extended structure. You can use a ring distribution (RING) with an inner rim (Parameter 4) and outer rim (Parameter 5) of 12 and 30 mas, respectively.

Compute an extended ring having a flux contribution smaller than the stellar flux (i.e. Parameter 3 = 0.9 for the DISK and 0.1 for the RING). Increase now the flux contribution of the ring.

- ix. What are your conclusion about the behaviour of the visibility profile? Do you understand it?
- x. For which kind of object should we expect this kind behaviour?

Come back to the scenario involving Parameter 3 = 0.9 for the DISK and 0.1 for the RING and plot the corresponding visibility curve.

xi. Could you find an appropriate configuration to determine the parameter values of each component?

xii. From the formula:

$$V = f_{\text{star}}/(f_{\text{star}}+f_{\text{rim}})*V_{\text{star}} + f_{\text{star}}/(f_{\text{star}}+f_{\text{ring}})*V_{\text{ring}},$$
  
could you recover the parameters of flux ratio?