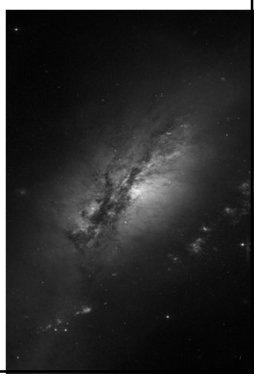
Physics of Galaxies 2020
Course introduction


Outline for today

Formal Stuff:
- Introduction to Zoom
- Course format
- Course literature
- Schedule
- Examination

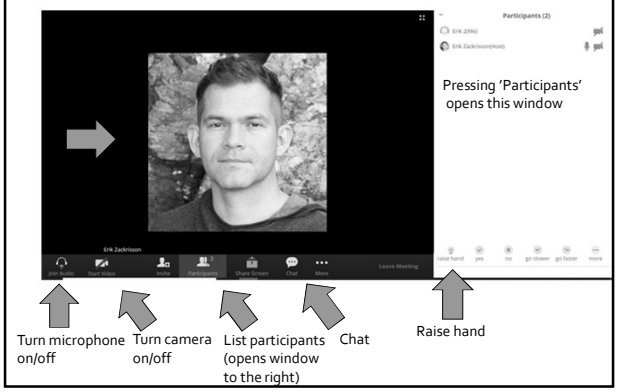


Zoom

Important features to master:
- Turning your microphone and camera on/off
- Use 'raise hand' symbol
- Use chat
- Share screen (computer only?)
- Share file/content

Using Zoom on a computer is the recommended way! And downloading the Zoom app is better than joining through a browser (not all browsers seem to be equally well-supported).

Quick quide to the computer Zoom client



Course homepage

- Link: www.astro.uu.se/~ez/kurs/Galaxies20.html

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The Physics of Galaxies, 10 ECTS (hp), Spring 2020

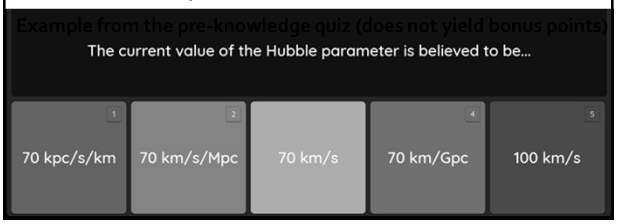
Literature:	Peter Schneider, 2015, "Extragalactic Astronomy and Cosmology", Springer, ISBN 978-3642540820 (hardback), 978-3662500606 (paperback) or 978-3642540837 (eBook) Please note that students of Uppsala University have free access to the eBook version of this title through the Uppsala University Library
Contents:	Extragalactic astronomy, with emphasis on the properties, evolution and origin of galaxies
Prerequisites:	Knowledge corresponding to a Bachelor's degree in physics, or similar. In addition, basic knowledge about spectra, stellar physics, galaxies and cosmology corresponding to the course Astrophysics I is required.
Examination:	Seminars, literature report, hand-in exercises, laboratory exercise

Course format 2020

- No full-scale Zoom lectures (too tediuous) – you should instead study the text book + lecture slides (largely from previous years) prior to each Zoom lecture session
- Lecture sessions (1 hour each) will be for Q&A and for covering the most difficult/important parts of the slides
- **Note:** This is all quite experimental – we may have to alter the format along the way if it doesn't work out

Digital quizzes coupled to each lecture session

- 8 quizzes for smartphone, computer or tablet
- Quizzes open as soon as I have time to design them
- Quizzes cover both textbook material and slides
- Deadline 48 hours after each session
- Infinite attempts until the deadline



Bonus points from quizzes

- 100% correct answers (no matter how many attempts it takes to get this) in a quiz → 0.5 bonus points added to hand-in exercise at the end of the course
- From 8 quizzes, you can get up to 4 bonus points
- The quizizz.com platform displays in-game points based on speed, but these are not relevant in this course
- Quiz scores are logged automatically when you complete a quiz – I can access these from an administratior page

Digital quizzes

https://join.quizizz.com

Game code: Different for every quiz. Check schedule for codes!

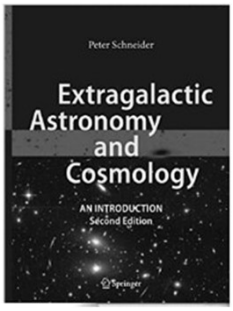
Important: You have to use your real name (not an alias) if you want bonus points. An asterisk (*) is automatically added to your name after each new attempt

Course literature

Extragalactic Astronomy and Cosmology
Peter Schneider
2014/2015, Springer
Hardback:
ISBN 978-3-642-54082-0
eBook:
ISBN 978-3-642-54083-7

Around 700-800 SEK

Note: E-version available from UU library (for free)



Examination

- Two exercise sessions
- Hand-in exercises (quizzes boost score)
- Three seminars
- One database exercise
- Written essay (minimum 3 pages) + oral presentation (10 minutes)

No written test!

Exercise sessions

- **Session 1:** April 23, 10:15-12:00
- **Session 2:** May 12, 15:15-17:00
- **Objective:** Solve problems *together* in small groups over Zoom (I sure hope this works!)

Exercise sessions

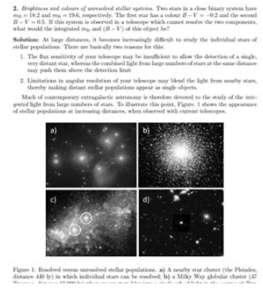
- **Preparation:**
  - Study exercises and solutions (posted on course homepage) before each session
  - Have pen, paper, calculator/computer, my solved exercises and textbook handy
- **Grade:** Pass/Fail

No-show or not actively participating → Need to complete more hand-in exercises

Exercises and solutions on the course homepage

Make sure you understand the solutions before exercise sessions I & II!

The problems we solve in the exercise sessions will be similar.



Hand-in exercises

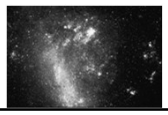
- 3 exercises downloadable from the course homepage
- Submit by email
  Deadline: June 3
- **Grade:** Fail, 3, 4, 5
- Collaboration OK, but please don't turn in identical solutions!

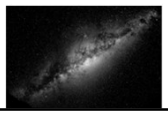
Physics of Galaxies
Hand-in exercises 2020

Note: If you didn't actively participate in the exercise sessions, you need to hand in additional exercises – please contact me if this situation should arise

Literature exercise

- Choose subject individually (should go well beyond treatment in textbook/slides, if covered by these)
- Find suitable articles
  - Published papers (ADS abstract service)
    http://adsabs.harvard.edu/abstract_service.html
    Preprints:
    http://www.arxiv.org
- Written report (≥ 3 pages), deadline May 18
  - **Grade:** Fail, 3, 4, 5
- Oral presentation (≈ 10 minutes), May 28, 29
  - **Grade:** Fail, 3, 4, 5



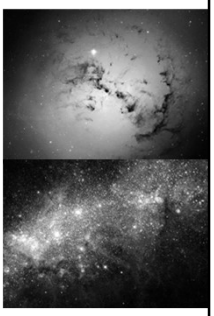


Required format of written report

- Abstract
- Introduction
- Main text (with references)
- Reference list
  - Should be mostly research or review papers
  - Please avoid using the textbook, popular science papers or homepages as references
    Exception: Links to project pages of upcoming telescopes, surveys etc. may be necessary if there is no proper paper out yet

Suggested topics

- The first stars
- 21 cm cosmology
- Origin of supermassive black holes
- Ultrafaint dwarfs
- Extragalactic background radiation
- Galactic archeology
- Conditions for life on galactic scales
- Science cases of future telescopes (pick one!):
  - James Webb Space Telescope
  - The Extremely Large Telescope
  - Square Kilometer Array



But please feel free to suggest other topics!

Seminars

- Small "simulations" of what working as a scientist is really like
- Three seminars:
  - 1. Three groups (join one!): May 13,14,15
  - 2. May 19
  - 3. Three groups (join one!): May 20, 25, 26

Soft
Soft
Tough!

Instructions available from course homepage!

Seminars

- Purpose:
  - Practice finding and reading relevant research papers
  - Practice critical thinking
  - Practice analyzing astronomical data
  - Practice scientific creativity
  - Practice communication skills
  - Practice working in a team
- What if you cannot attend the seminars?
  - Have to hand in written report instead (→ more work!)

Seminar I: Strange galaxy

- **Grade:** Pass/fail
- Puzzle-solving game aiming to teach you about observational techniques and observing strategies in extragalactic astronomy
- Preparation: Read section 1.3-1.4 in textbook

Seminar I: Strange Galaxy

General instructions

This document provides instructions for the first of the three seminars forming part of the examination for the course *Physics of Galaxies* in 2020. This is an exercise with game-like mechanics that aims to provide insight into some of the observational techniques commonly used in extragalactic astronomy.

In the *Strange* galaxy game, you will be assigned to different teams and presented with a sequence of observational problems to solve. Each such scenario involves a set of observational data on an unusual, poorly understood galaxy or other astronomical object. The objective is to understand the nature of the object by gathering additional information through carefully chosen follow-up measurements. There are many observational methods that can be applied in each situation (optical monitoring, ultraviolet spectroscopy, high-resolution near-infrared imaging etc.) and they all provide slightly different clues to the puzzle. Resources are, however, limited. At the start of each scenario, every team will be granted a limited research budget (in a fake, in-game currency), and every new measurement that you choose to make will set you back by a certain amount. The objective of the game is to crack the puzzle before running out of funding.

Seminar II: An amazing discovery / Crackpot?

- **Grade:** Pass/fail
- Role-playing exercise
- Preparation:
  - Study the two scenarios in the instructions
  - Read the material available in the student portal

Seminar II: An amazing discovery / Crackpot?

General instructions

This document provides instructions for the second of the three seminars forming part of the examination for the course *Physics of Galaxies* in 2020. This is a role-playing exercise that will cast you into situations that scientists (and especially astronomers) frequently encounter, yet in general tend to be rather poorly prepared for.

The point of this exercise is to:

- Practice reading research papers, press releases and other scientific texts in the field of extragalactic astronomy
- Practice critical thinking
- Practice interacting with the public and with journalists in a professional manner, and also to get some feeling for what it may feel like to be on the other side of this conversation.

This seminar features two separate role-playing scenarios - *An amazing discovery* and *Crackpot?* - with each scenario revolving around the meeting of two different characters. Each scenario will take about one hour to enact, including some time to get into character at the start of each scenario and some time for feedback and discussions afterwards.

Seminar III: The most distant galaxies

- **Grade:** Fail, 3, 4, 5
- Preparation:
  - Read suggested papers + others
  - Answer questions + analyze dataset
  - Prepare to present answers and results in class

Seminar III: The most distant galaxies

General instructions

This document provides preparation instructions for last of the three seminars forming part of the examination for the course *Physics of Galaxies* in 2020. The topic of this seminar is *The most distant galaxies*.

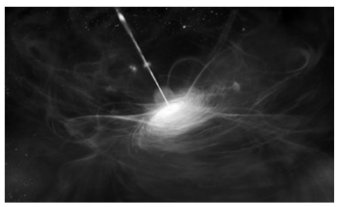
Galaxies are being detected at ever-increasing redshifts, and as of 2020, a number of photometric galaxy candidates have been claimed at $z \approx 10$–12, i.e. at about 300-500 Myr after the Big Bang. So far, only one such object has been confirmed through spectroscopy ($z = 11.1$), but the race to detect even more of these primordial galaxies is on.

The point of this exercise is to:

- Practice reading technical research papers (as opposed to popular articles, review papers or textbooks). As a professional astronomer, most of the stuff you will read is likely to be of this variety.
- Practice critical thinking (for this purpose, speculative and controversial seminar topics have deliberately been chosen).

Database exercise ("lab")

- Introduction to exercise in lecture session 6
- Complete individually and hand in report no later than June 5
- **Grade:** Fail, 3, 4, 5



Grades

- Final grade will be the mean grade from:
  - Seminar 3
  - Written report on literature exercise
  - Oral presentation of literature exercise
  - Report from database exercise
  - Hand-in exercises
- No final grade will be computed until you have a reached a passing grade (3 or higher) for each of these
- Please note that you also need a passing grade from the two exercise sessions and seminar 1 & 2 to complete the course

Grades – example

1) Seminar 3
   Grade: 4
2) Written report on literature exercise
   Grade: 4
3) Oral presentation on literature exercise
   Grade: 3
4) Report on computer exercise
   Grade: 5
5) Hand-in exercises
   Grade: 3

Calculate mean grade: (4+ 4+ 3 + 5 +3) /5 = 3.8 ≈ 4
Final grade: 4:

Pro tip

Note: There is a gap in the schedule between April 1 and April 20

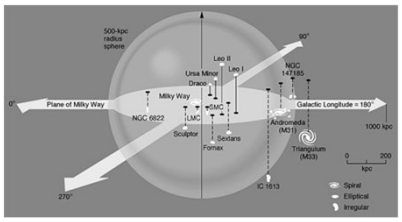
Friendly advice: Decide on a topic for the literature exercise early and use this time to work on the written report – otherwise things will become very hectic in late May

Course Outline

- Lecture 1:
  - Introduction
  - Historical Background
  - Galaxy Classification
  - The Cosmological Framework

Course Outline

- Lecture 2:
  - The Astronomical Distance Scale
  - The Milky Way
  - The Local Group



Course Outline

- Lecture 3:
  - Dark matter in galaxies
  - The dark halo
  - Subhalos
  - Mass-to-light ratios
  - Baryon fractions

Course Outline

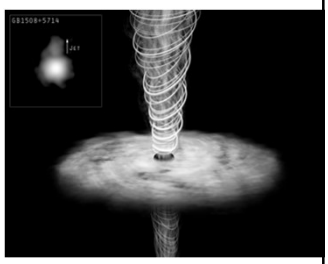
- Lecture 4:
  - Disk galaxies
  - Elliptical galaxies

Course Outline

- Lecture 5:
  - Star formation
  - Population synthesis
  - Galaxy spectra
  - The interstellar medium
  - The cosmic star formation history

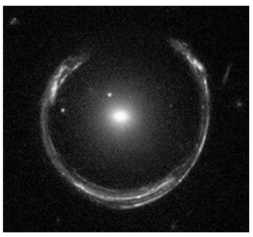
Course Outline

- Lecture 6:
  - Black holes
  - Active galaxies:
    - Quasars
    - Blazars
    - Seyfert Galaxies
    - Radio Galaxies
  - Introduction to database exercise



Course Outline

- Lecture 7:
  - Galaxy groups
  - Galaxy clusters
  - Gravitational lensing



Course Outline

- Lecture 8:
  - The high-redshift Universe
  - Cosmic reionization
  - The first stars and galaxies