SYLLABUS for course ASTB23, Title: Stars, Galaxies & the Universe Fall 2016

Fall 2016. The contents will evolve, please download the updates every week.

Lectures: Thursdays 12-14 PO101 (portable unit). Tutorials Thursdays 16-17 PO101.

Calendar od lectures (L1...L24) and tutorials (T1...T10).

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8 Sept. L1 + L2, --

15 Sept. L3 + L4, T1 (last day to add/remove courses on ACORN)

22 Sept. L5 + L6, T2

29 Sept L7 + L8, --

6 Oct. L9 + L10, --

13 - no meetings, reading week

20 Oct. L11 + L12, T4 <------- An in-class midterm during L12

27 Oct. L13 + L14 T5

3 Nov L15 + L16, T6

10 Nov. L17 + L18, T7

17 Nov. L19 + L20, T8

24 Nov. L21 + L22, T9 (last day to drop courses w/o acad penaly)

1 Dec. L23 + L24, T10

preliminary date: 5 Dec. 14-17 in MW140 <-------- Final exam

[2 double-sided hand written (not printed or photocopied) sheets of own notes

are allowed at midterm, and 3 such sheets during the final exam.

Calculators are required. No books, phones, electronic devices allowed.]

Office hours: right after lectures, right after tutorial, other times as well,

stop by and ask if you can talk to me.

Note: This syllabus will be updated during the course. Please check regularly

this file, and contents of http://planets.utsc.utoronto.ca/~pawel/ASTB23

Topic number coincides only approximately with lecture number, but the titles usually correspond to the relevant chapter titles

in the textbook #1.("What are the stars"), #2 ("Life and death of stars"),

or #3 ("Galaxies in the Universe"; see web page for more info on textbooks).

The relevant chapters/sections of the textbooks 1...3 are indicated as,

for instance, textbook1 Chapter 5.1, => [1-5.1], while [L10] would indicate

Lecture10 in PDF/PPT form, posted on our web page

0. Organization and goals of the course

1. Introduction to stellar (and planetary) astrophysics [L1]

* Unification of planetary sciences, connections w/physics

* Comments on the history of the idea of other stars and planets

2. The Present Revolution in Astronomy: An Overview

[1-Unnumbered] From p. xvii of textbook 1.

PLEASE READ - it's a very good overview, we skipped it

during the lecture as it is indeed long, but you should

read the whole 150+ page textbook, and questions from the this

Overview may be asked on the quiz, as they relate to the Universe, for instance.

Until the midtem, we will follow closely our textbook 1 ("What are the stars")

Book 1:

1 What are the Stars?
- * Historical Introduction
- * The Photosphere
- * The Interior of the Sun
- * The Virial Theorem

2 Stars as Globes of Gas
- * A Theory of the Stars
- * Hydrostatic Equilibrium
- * Why Does the Sun Shine?
- * Source of Energy

3 Eddington’s Theory of the Stars
- * Radiation Pressure
- * Radiative Equilibrium
- * Basic Equations of Stellar Structure
- * Solution of the Equations of Stellar Structure

Lecture 13 Formation of disks and stars

* Giant molecular clouds
* Jeans instability of protostellar cloud cores
* Opacity-limited fragmentation
* Simulations: the ubiquity of protostellar disks, brown dwarfs

11. {20 October} = Mid-term exam (in class during tutorial)

[hereafter, chapter numbers refer to the 'Galaxies in the Universe' textbook]

13. Accretion disks [9]

* AGN and quasars: accretion onto `black' holes
* Accretion disk geometry
* Disks as evolving, shearing flows
* Collapse simulations using SPH (smoothed particle hydrodynamics)

14. Introduction, The Milky Way [1]

[1.a] History of the discovery of the Galaxy

[1.b] The Great Debate about galaxies

[1.1] The stars

[1.2] Our Milky Way

15. [1.3] Other galaxies, Galaxy photometry

Hubble sequence, other classifications

[1.4] Galaxies

Typical properties and statistics of of galaxies

Gauss theorem and examples of its use. Laplace equation

Gravity force and potential

Spherical systems & Newton's theorems

Potentials of some simple systems

Potential- density pairs of flattened systems

16. [2] Mapping our Milky Way

[2.1] The solar neighborhood 2.2 The stars in the Galaxy

The vertical structure of the disk / Distances to star clusters /

Bottliger diagram, asymmetric drift

17. [2.3] Galactic rotation

Infrared & radio view of the Milky Way

Glactic bulge and Center (Nucleus)

Measuring the Galactic rotation curve

18. Relaxation and evolution, part I

[3] The orbits of stars

[3.2] Why the Galaxy isn't bumpy: two-body relaxation, encounters

Relaxation time: theory and the inferred histogram for globular clusters

19. Relaxation and evolution, part II

The virial theorem with consequences / Evaporation and mass segregation/

Effects of two-body relaxation: core collapse of globular clusters

in numerical simulations

[3.x] Angular momentum and energy conservation in stellar motion

Epicyclic theory of orbits in galactic potentials

epicyclic frequecy, vertical frequency, azimuthal frequency

and corresponding periods

20. [4] Our backyard: the Local Group

4.2 Spirals of the Local Group

The Andromeda galaxy / M33: a late-type spiral

[5] Spiral and S0 galaxies

[5.3] Gas motions and the masses of disk galaxies

21. Rotation Curves and Spiral Arms in Galaxies

Decomposition of rotation curves. Two types of rotation curves.

Dark matter in disk galaxies

The Tully-Fisher versus the Faber-Jackson relationship

[5.4] Spiral arms and galactic bars

Observed spiral patterns: trailing vs. leading spirals

Disk Dynamics and Spiral Structure

Dispersion relation for gaseous disks

Long waves / Short waves / Toomre stability of disks

SWING amplifier

Lin-Shu theory of spiral modes and WASER cycle

Correlation of rotation curve with the type of spiral pattern:

physical explanation of spiral galaxy classification

22. Bars as a by-product of spiral mode evolution

Encounters and Mergers

23. Gravitational lensing

[6] Elliptical galaxies

[6.2] Motions of the stars

The Faber-Jackson vs. Tully-Fisher relations

[6.5] Galaxy clusters: the domain of elliptical galaxies

Elliptical galaxies: nature, nurture, or merger?

Masses of galaxy clusters

Supermassive Black Holes and Active Galactic Nuclei [8]

early history of galaxies

24. The Universe

[7] Large-scale distribution of galaxies

[7.1] Observations of large-scale structure: galaxy clustering

[7.2] Expansion of a homogeneous Universe

[7.3] Growth of structure: peculiar motions

clusters, walls, and voids

[8.3] Cosmic Microwave Background Radiation (CMBR) - satellite observations.

Observational proof of a flat spacetime in our universe: Boomerag and WMAP experiments

The universe in 21st century: Einstein's cosmological constant Lambda returns (Dark Energy)