ASTR 1040: Accel Intro Astron 2

Stars & Galaxies

Two merging galaxies
HST: NGC2207 / IC2163

Prof. Juri Toomre TAs: Max Weiner, Daniel Sega, Loren Matilsky

Tues/Thur 11:00am, Duane G-130

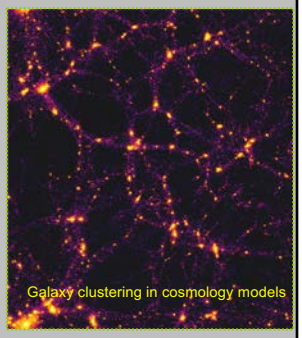
Lecture 1 14 Jan 2020

Detailed course syllabus passed out

zeus.colorado.edu/astr1040-toomre

Who SHOULD take this course?

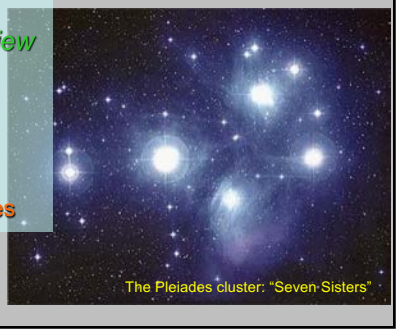
- *Astronomy/Astrophysics, Physics & Engineering majors*
- *with prereq ASTR 1030*
- *Moderate amounts of quantitative work (algebra)*
- *with prereq/coreq MATH 1300 or APPM 1350*



Galaxy clustering in cosmology models

Beginning of Today's Class

- Course goals
- Course overview
- Course information
- Introduction: Sizes and Scales



The Pleiades cluster: "Seven Sisters"

Course Goals

Develop a broad view of what we think we know about the universe

Understand the forces that shape the universe and its history

Appreciate the beauty and richness of what goes on

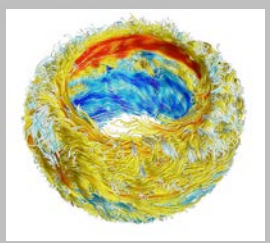
Quintuplet galaxy cluster

Course Goals (more general)

- *Learn critical thinking skills*
  - how to think, reason, and argue scientifically, using logic, observation, and evidence
- *Understand how we know what we know about the universe*
  - and what we don't yet know!
- *Gain knowledge and appreciation of the scope, scale, and phenomena of the physical universe*

Galaxy cluster

Who am I …



Theoretical astrophysics: *Stellar convection and magnetism*

Who are you…

- Introduce yourself to 2 neighbors:
  - –Trade names, hometowns, interests, etc.
  - –Why are you taking this course?
  - –What topics do you most want to learn about in this class?
- We'll try to get to know you throughout the semester but you can help by…
  - –Asking questions
  - –Answering questions
  - –Coming to see us in office hours
  - –Volunteering for demos

Course Information

COURSE PRIMARY WEB PAGE:
zeus.colorado.edu/astr1040-toomre

Can find info on all assigments (passed out in class), course calendar, lecture notes, reading schedule

Grading is shown on course Canvas site – and MMA access

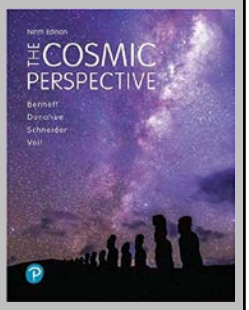

"Planetary" nebula

Required Text or eText

The Cosmic Perspective
by Bennett et al. 2020 9th ed
Should include:
Access to new online
Modified Mastering Astronomy

Sign-up via our course Canvas site using nav tab: MyLab & Mastering

Join our MMA course there:
ASTR1040TOOMRE2020 (use code from "pink handout sheet")



How to succeed in this course

- *GOT TO PUT IN THE TIME:*
  4 credits at CU →
  6 to 10 hours outside of classroom (no kidding)
- Read sections *BEFORE* discussion in class (secrets of memory)
- Come see us during office hours or Astronomy Help Room!


Galactic jets from "active" galaxy

Important classroom policies

- Working together on homework is encouraged, *BUT:*
- Your answers must be in your own words -- copies will be awarded split credit
- Cite sources on all write-ups
- Web submissions must be done independently
- Using another person's clicker is cheating
- *Students are expected to follow the CU Honor Code*

Read all course information in your syllabus handout (after class)!

Three in-class mid-term exams (m/c, short essay, qualitative analysis): 45%

Homeworks (weekly, including MMA): 20%

Final exam: 25%

Clickers + discussion contributions + observing: 10%

There are no make-up exams or late turn-ins

i-clickers (radio frequency)

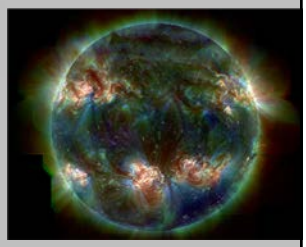
- Required -- bring to each class and recitation!
- Register clicker to your CU identikey name by Thurs class (by logging into MyCUInfo or OIT site)
- Used for reading quizzes, in-class discussion questions, feedback

Observatory Nights

- Starting Thur 30 Jan at 7:00pm, then about every ten days (8 in all) – *go to at least one session by signup*
- *Sommers-Bausch Observatory* (next to Fiske): two new 20" + 24" telescopes

Got Questions?

- Textbook?
- Clickers?
- Office Hours?
- Exam Policy?
- MasteringAstronomy?
- Observing Nights?



Syllabus or course main website
zeus.colorado.edu/astr1040-toomre

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Recitations

crucial part of course

Two merging galaxies
HST: NGC2207 / IC2163

- We have five *weekly 50 min recitations (assigned)*:
- ***Max Weiner:*** ***011:*** Tues 3pm (D-318); *013*:* Wed Noon (D-142)
- ***Daniel Sega:*** ***015:*** Wed 10am (D-142); *012*:* Wed 11am (D-142); *014:* Wed 1pm (D-142)
- *Loren Matilsky and Max* cover for Daniel first 3 weeks

Electronic Device Policy

- Turn off your phones.

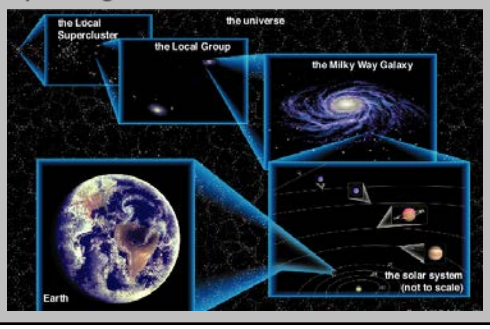
- If your wish to takes notes on a laptop or tablet, please sit on the left-hand side of the room.

Course Overview

What we will study

Sizes and Scales

- Vast range of *SIZES and SCALES*, finding our way through the universe

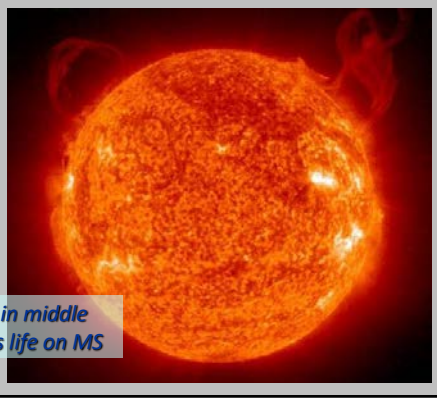


Light (Electromagnetic Radiation)

- *What is light?*
- *How do we use it to find out what and where things are?*
- *Waves vs particles*

Telescopes (Tools of the Trade)

Our Nearest Star : The Sun



Star in middle of its life on MS

STELLAR Birth and Life

STARS of very many sizes and colors

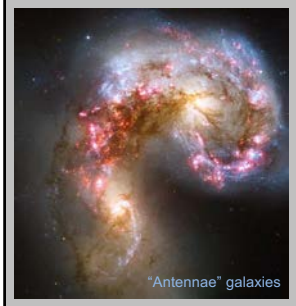
Evolution path and color / brightness Depends on MASS

STAR DEATH: white dwarfs, supernovae, neutron stars, black holes

OUR GALAXY : The Milky Way

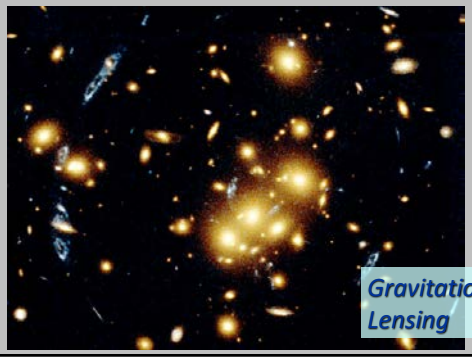
Exploring a Universe of GALAXIES

GALACTIC evolution

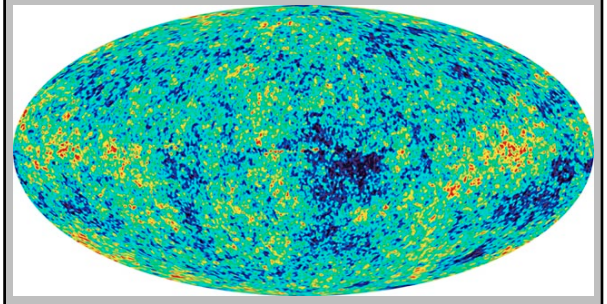


Galaxy collisions, quasars

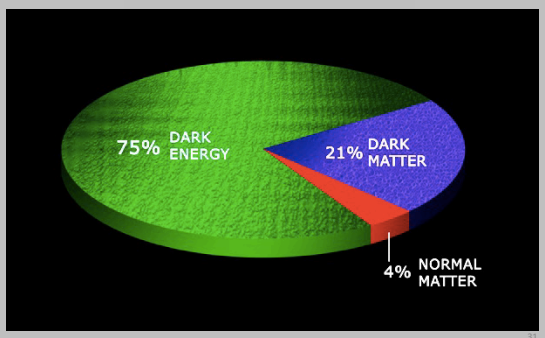
Dark matter and lensing of background galaxies



BIG BANG beginning



Dark Matter, Dark Energy and the Fate of Universe



What this course is NOT?

Astronomy is not Astrology!!!

What this course is NOT?

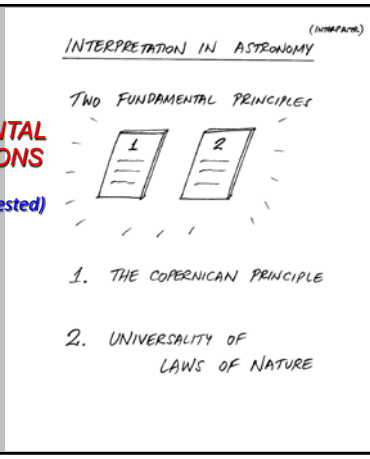
Memorizing Constellations

Topics for Today and Thursday

- Nature of astronomy as a science
- Scientific method: we observe, hypothesize, test its predictions, maybe fix it and try again
- Mystery of planetary orbits: gravity makes you move on ellipses (..Kepler, Newton)
- Light as waves (and as particles)
- Special colors of light associated with each element

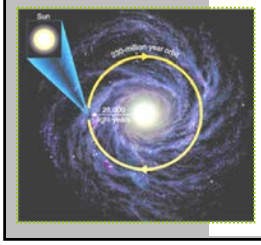
FUNDAMENTAL ASSUMPTIONS

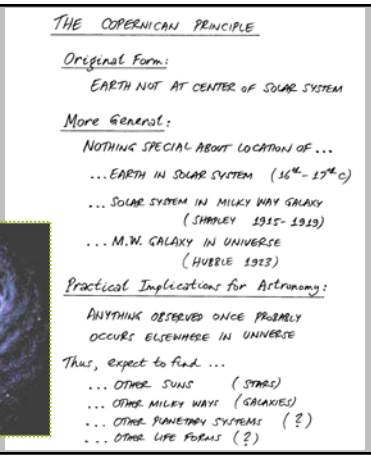
(always being tested)



COPERNICAN PRINCIPLE

Copernicus (1473-1543)





UNIVERSALITY OF `LAWS'

ATOMS BEHAVE THE SAME EVERYWHERE

(we hope, and keep testing !)

GRAVITY ACTS EVERYWHERE

UNIVERSALITY OF LAWS OF NATURE

SAME GENERAL LAWS APPLY EVERYWHERE IN UNIVERSE

Examples:

- PROTONS AND ELECTRONS ON EARTH SAME AS THOSE ON SUN
- ATOMS OF DIFFERENT ELEMENTS THE SAME EVERYWHERE
- MOON ORBITING EARTH OBEYS SAME RULES OR " = " STAR ORBITING ANOTHER STAR
- GRAVITY HOLDS TOGETHER .... STAR ... GALAXY ... CLUSTER OF GALAXIES ... ACCORDING TO ONE LAW

SCIENTIFIC `LAWS' are constantly being tested

Sec 3.4: Nature of Science

FOUR FUNDAMENTAL FORCES

At work everywhere, "Universal" – we assume and test

FOUR TYPES OF FORCES IN NATURE

1. GRAVITY
   WEAKEST, BUT DOMINATES UNIVERSE
2. ELECTROMAGNETIC (EM)
3. STRONG NUCLEAR
   100 x EM, BUT ONLY IN NUCLEUS OF ATOM
4. WEAK NUCLEAR
   1/1000 x EM, ONLY IN ATOMIC NUCLEUS

ELECTRO-MAGNETIC RADIATION

(used for most deductions)

PHOTONS (quanta – particles of light)

ELECTROMAGNETIC RADIATION (EMRAD)

γ-RAYS, X-RAYS, UV, VISIBLE, IR, MICROWAVE, RADIO
← "LIGHT" →

ACT BOTH LIKE
WAVES AND PARTICLES
(PHOTONS)

PHOTONS
SMALLEST PACKETS ("QUANTA") OF LIGHT ENERGY

QUANTUM NATURE OF LIGHT MOST EVIDENT WHEN LIGHT INTERACTS WITH ATOMS
⇒ SPECTRAL LINES

For Thurs class meeting, read/review:

How to Succeed in this course, p. xxiv+

- Chapter 1, all *(Our Place in Universe)*
- Review *Basic Astronomical* terms, p. 6
- Chap 3, sec 3.3, 3.4 *(Kepler, Nature of Science)*
- Chap 4, read all *(Making Sense of Universe)*
- Begin reading Chap 5, carefully *(Light and Matter)*
- You can get a copy of these slides after class from course website (can be helpful)

Modified Mastering Astronomy (MMA) + homeworks

- **Online MMA Assignment (HW # 0) available NOW**
  Walks you through how to submit all the assignments and MMA resources available, and some review of concepts (good practice, extra credit)
  Complete by Tues Jan 21, 6pm
- **Homework # 1 on "Light & Spectroscopy"** now available (green sheet), *involves both MMA portion and written portion, to be turned in by Thur Jan 23 class*
- Get your MMA account set up asap, linking to "ASTR1040TOOMRE2020" -- on Canvas, use MyLab & Mastering tab to get there, and access code from "pink sheet" – your login from 1030 should be helpful