Outline

- Go over problem 5-3
- Interstellar medium
- Molecules
- Atomic hydrogen
- Dust
- Reddening
- Dynamics

Colloquium on Monday:
“The Path to Magnetic Fusion Energy”
by Professor Stewart Prager, Princeton Plasma Physics Laboratory

Interstellar Medium

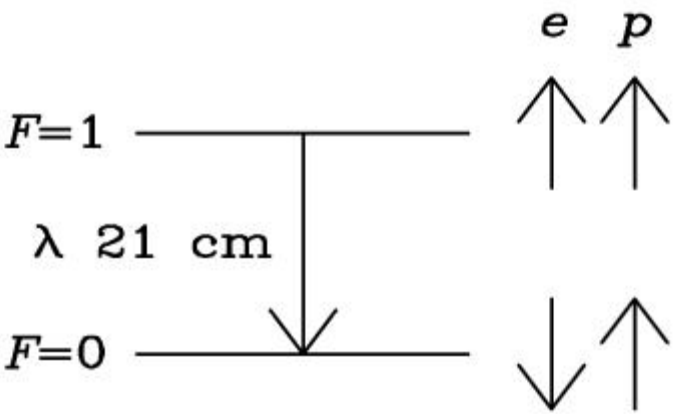
- Interstellar medium (ISM) contains:
  - ionized gas
  - neutral gas
  - molecular gas
  - dust
  - cosmic rays

- How do we see these components?

Interstellar Medium

- Ionized gas – optical, UV, IR emission lines

- Neutral gas
  - absorption lines
  - Spin-flip or hyperfine transition of HI makes 21 cm radio line emission



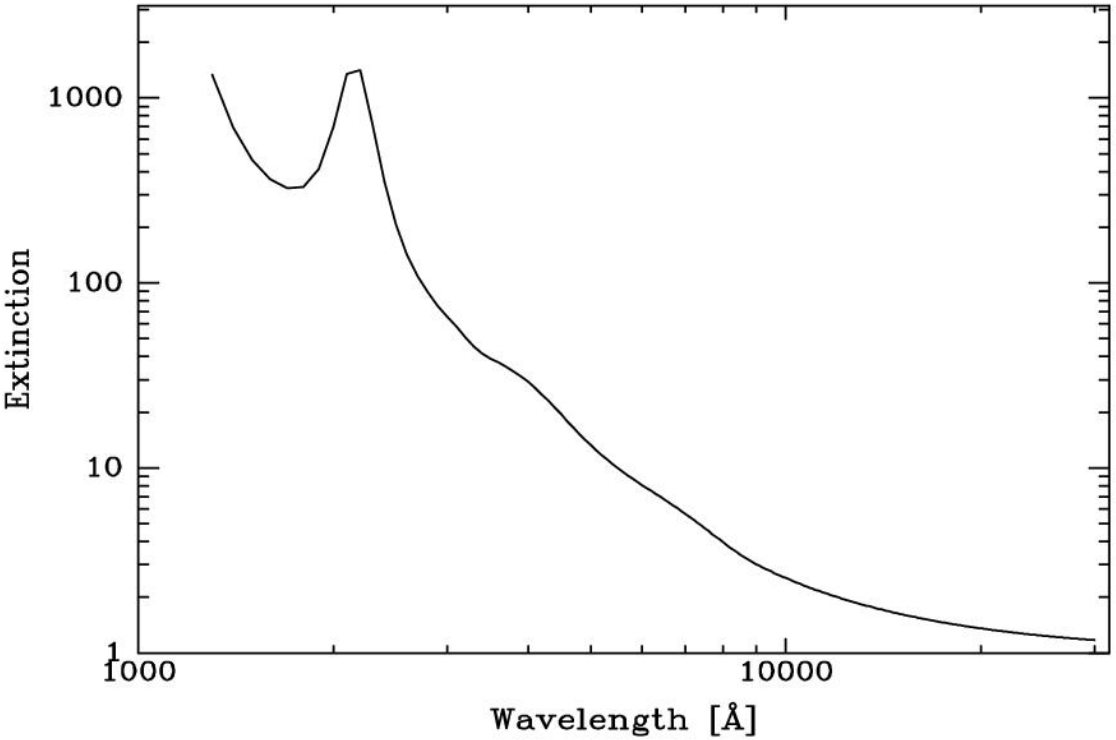
- Molecular gas
  - H_2 is inefficient radiator – too symmetric
  - CO often dominant coolant
  - OH, NH_3, complex molecules
  - stimulated emission from masers

Dust

- Grains containing Fe, Si, C, H_20, $C0_2$ (ice)
- Sizes typically 1-250 nm
- Produced in evolved stars and supernovae

- Usually seen in absorption = reddening
- Dust produces infrared emission
  - blackbody at dust temperature, 20-100 K
  - lines from dust components, notable polycyclic aromatic hydrocarbons (PAHs)

Reddening / Extinction



- Dust absorbs more strongly at short wavelengths.
- Curve of absorption versus wavelength is a “reddening curve” or “extinction law”. Depends on dust properties (distribution of grain sizes).
- Need to correct for reddening when measuring fluxes or spectra.
- Usually use “Balmer decrement”. In most nebulae, emitted ratio $H\alpha:H\beta:H\gamma = 2.8:1.0:0.47$.
- Use observed $H\alpha:H\beta:H\gamma$ and find extinction that best fits the data (with assumed reddening curve).

Dynamics of ISM

- Newly formed stars ionize the ISM.
- Winds from evolved stars, novae, and supernova circulate products of nuclear burning into the ISM.
- Galaxy-galaxy interactions disturb the ISM, often enhancing star formation.

Dynamics of ISM

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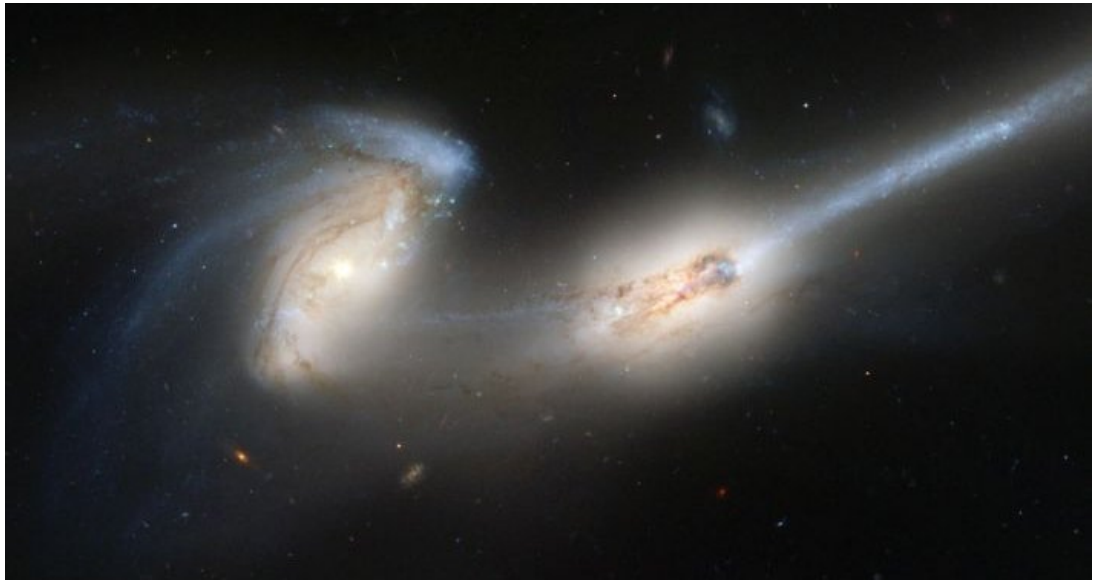
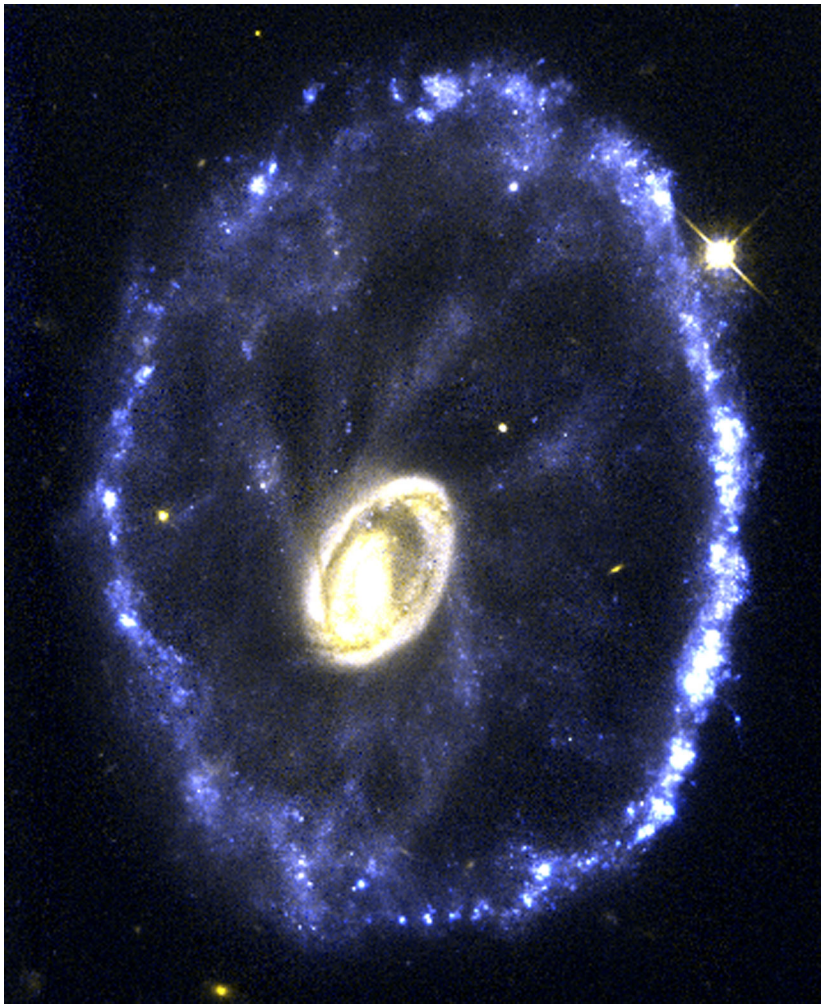
Dynamics of ISM





- Galaxy-galaxy interactions disturb the ISM, often enhancing star formation.

Homework

- For next class: problem 5-4