Syllabus[1]

Week 1 (Feb. 4): *Supernovae: An Overview*

Topics covered – The cosmos, and the fundamental role of supernovae. Review of basic physics: Newtonian dynamics and mechanics; gravitation; gravitational self-binding energy.

Required Reading:
Course Reader: *Messages in Starlight*, by Laurence Marschall, p.4-14. *Guest Stars*, by Murdin & Murdin, p.16-28.
Carroll & Ostlie: Chapter(s)/section(s) 2.2; 10.3 (partial)

Optional Background Material:
Abell: Chapter(s)/section(s) 3
Hewitt: 2-10, 12, 13
Ohanian: 2-9
Halliday: 2-8, 15

Week 2 (Feb. 11): *Light: It's all We Have*

Topics covered – An astronomical toolkit: Flux, luminosity, magnitude scale, distance modulus, ''standard candles'', the angstrom unit, color index, *UBVRI* photometry filters. The best way to measure distances: trigonometric parallax. Light: wave nature, electromagnetic spectrum, blackbody radiation, Planck function, Wien's displacement law, the Stefan-Boltzmann equation. A thermal supernova spectrum.

Required Reading:
Course Reader: Begin *On Supernovae*, by Baade & Zwicky (1934), p.30-35 (end at equation [15]).
Carroll & Ostlie: 3.1, 3.2, 3.3, 3.4, 3.5 (lightly), 3.6

Optional Background Material:
Abell: 7.1, 7.2, 21.1, 21.2, 22.1, 22.2
Hewitt: 27 & 31
Ohanian: 36 & 39
Halliday: 21.7, 38, 40

Week 3 (Feb. 18): *Special Relativity*

Topics covered – Einstein's postulates and their implications: time dilation, length contraction, and the downfall of simultaneity. Doppler shift; redshift and blueshift; relativistic energy.

Required Reading:
Course Reader: Finish *On Supernovae*, by Baade & Zwicky, p.35-36
Carroll & Ostlie: 4

Optional Background Material:
Abell: 8, 27.2
Hewitt: 15, 16 (excellent introduction to special relativity)
Ohanian: 41
Halliday: 8.8, 42

[1] Subject to change!

Week 4 (Feb. 25): *The Fingerprints of the Elements*

Topics covered – Spectral lines; Kirchhoff's Laws; photons; the hydrogen atom; Pauli exclusion principle and degeneracy; introduction to supernova spectral classification.

Required Reading:
Course Reader: *Spectra of Supernovae*, by Minkowski (1941), p.38.
Carroll & Ostlie: 5.1 (partial), 5.2, 5.3 (partial), 5.4 (very lightly).

Optional Background Material:
Abell: 7.3, 7.4
Hewitt: 28.11
Halliday: 43

Week 5 (March 4): *Understanding Supernova Spectra*

Topics covered – Brief introduction to stellar spectra; Maxwell-Boltzmann distribution function; Hertzsprung-Russell Diagram: an empirical classification scheme; opacity; line blanketing; mean free path; optical depth; photosphere; radiative transfer in moving atmospheres: the anatomy of a P-Cygni line profile.

Required Reading:
Course Reader: Begin *Spectra of Supernovae*, by David Branch (1990), p.40-47.
Carroll & Ostlie: 8.1 (partial); 8.2; 9.2 (partial); p.470 (P-Cygni line profile).

Optional Background Material:
Abell: 22.3, 22.4, 24.2
Halliday: 21.7

Week 6 (March 11): *Why Stars Explode I*

Topics covered – Stellar energy sources; overview of main sequence and post main sequence stellar evolution; Kelvin-Helmholtz, free-fall, and nuclear timescales; the neutrino; binding energy per nucleon; white dwarfs: the fate of stars with $M \lesssim 8M_{\odot}$; core-collapse supernovae: the fate of stars with $M \gtrsim 8M_{\odot}$; explosion mechanism in core-collapse supernovae; radioactive-decay powered light curves; brief introduction to pulsars; SN 1987A.

Required Reading:
Course Reader: Begin *Why Stars Explode*, by Laurence Marschall (1988), p.76-85; *Supernovae, Type II, Theory and Interpretation*, by Stan Woosley (1992), p.72-75; *The Making of a Neutron Star*, by Murdin & Murdin (1985), p.90-100.
Carroll & Ostlie: 12.2 (p.451, homologous collapse); 13.1 (partial); 13.2 (partial); 13.3.

Optional Background Material:
Abell: 27, 29, 30
Hewitt: 40
Halliday: 47.5, 48.6, 48.7

Week 7: *Spring Break*

Topics covered – Matter at rest.

Week 8 (March 25): *Why Stars Explode II*

Topics covered – The light curves and spectra of core-collapse supernovae: Types II-P, II-L, IIn, Ib, and Ic; ''hypernovae''; Physics of degenerate matter; white dwarfs; Chandrasekhar limit; Type Ia supernovae.
→Mid-semester individual meetings take place.

Required Reading:
Course Reader: Finish *Spectra of Supernovae*, by David Branch (1990), p.48-54. *Classification of Supernovae*, by Harkness & Wheeler (1990), p.56-70. Finish *Why Stars Explode*, by Laurence Marschall (1988), p.85-88. *Review on the Observed and Physical Properties of Core Collapse Supernovae*, by Mario Hamuy (2003), p.122-147
Carroll & Ostlie: 15.1; 15.2 (partial); 15.3; 15.4; 17.4 (partial).

Optional Background Material:
Abell: 30

Week 9 (April 1): *Fun With Supernovae*

Topics covered – Explosion geometry from polarization studies; time-dilation from studies of Type Ia supernovae; Type Ia supernovae as standard candles; Type II-P supernovae as primary distance indicators through the expanding photosphere method; supernova-gamma-ray-burst connection; interstellar extinction.

Required Reading:
Course Reader: *Supernova Light Curves*, by Bob Kirshner (1990), p.112-121; *Probing the Geometry of Supernovae with Spectropolarimetry*, by Doug Leonard (2000), p.148-151; *Time Dilation from Spectral Feature Age Measurements of Type Ia Supernovae*, by Adam Riess et al. (1997), p.160-167; *Time Dilation in the Light Curve of the Distant Type Ia Supernova SN 1995K*, by Bruno Leibundgut et al. (1996), p.168-171; *The Absolute Magnitudes of Type Ia Supernovae*, by Mark Phillips (1993), p.172-175
Carroll & Ostlie: 12.1 (partial), 25.1 (partial), 25.4 (lightly)

Optional Background Material:
Abell: 25

Week 10 (April 8): *The Expansion of the Universe*

Topics covered – Hubble's law; Newtonian cosmology: cosmological principle, dust-filled universe, critical density, look-back time, deceleration parameter.

Required Reading:
Carroll & Ostlie: 25.2, 27.1

Optional Background Material:
Abell: 33

Week 11 (April 15): *Relativistic Cosmology*

Topics covered – Brief introduction to the general theory of relativity; Schwarzschild metric; Robertson-Walker metric; Friedmann equation; the cosmological constant.

Required Reading:
Course Reader: Begin *The Cosmological Constant* by Carroll et al. (1992), p.176-178
Carroll & Ostlie: 16.1 (partial); 16.2 (lightly); 27.3

Optional Background Material:
Abell: 31

Week 12 (April 22): *The Accelerating Universe*

Topics covered – Observational cosmology; luminosity distance and Mattig's formula; observations of Type Ia supernovae; basics of error analysis; confidence limits; the supernova discovery; the effects of a nonzero cosmological constant; the fate of the Universe.

Required Reading:
Course Reader: Finish *The Cosmological Constant* by Carroll et al. (1992), p.178-189; *Error Analysis* by Ben Mathiesen (1997), p.194-217; *Confidence Limits on Estimated Model Parameters* by Press et al. (1992); *The Case for an Accelerating Universe from Supernovae* by Adam Riess (2000), p.224-239; *Supernova Explosions in the Universe* by Adam Burrows (2000), p.152-158
Carroll & Ostlie: 27.4 (partial)

Week 13 (April 29): *Ending it All*

Topics covered – Wrap-up and philosophical musings.
→Final individual meetings, May 5-9.