ASTRONOMY 124 TEST #1 REVIEW

Introduction
   The Chandra X-ray Observatory

Night Sky
   Contents, Angles, Seeing
   Motions
      Rotation and Revolution of Earth

Basic Stellar Properties
   Parallax
      Stellar Distances, Parsec
   Proper Motion
   Scientific Notation
   Brightness and Magnitude
      Colors, Absolute Magnitude

Light
   Energy
      Kinetic and Potential
      Conserved
      Luminosity, Brightness
      Dependence on Distance
   Electromagnetic Waves
      Produced by Moving Charges
      Wavelength and Frequency
   Electromagnetic Spectrum
      Radio, Infrared, Visible, Ultraviolet, X-ray, Gamma-ray
         (in order of decreasing wavelength)
      Red, Orange, Yellow, Green, Blue, Indigo, and Violet
         (ROY G. BIV, in order of decreasing wavelength)
   Doppler Effect
      Measures Radial Velocity
      Moving Away \(\to\) Redshift
      Moving Towards \(\to\) Blueshift

Photons
      Higher Frequency \(\to\) Higher Energy

Telescopes
   Reasons for:
      Collect more light
      Better resolution
      Observe non-visible radiation
   Resolution vs. wavelength and aperture
      Interferometers
   Optical telescopes
      Refractors, Reflectors
   Recent telescopes
Temperature and Heat
Atoms
Heat is kinetic energy of atoms (total)
Temperature is kinetic energy of each single atom

Thermal Radiation
Temperature increases → more radiation
Temperature increases → higher frequencies
$L \propto R^2 T^4$ for stars

Radii of Stars
Main Sequence, Giants, Supergiants, White Dwarfs

Atoms and Radiation
Spectral Lines
Composition of Stars
Mainly Hydrogen and Helium, heavier elements rarer

Kirchhoff’s Laws
Hot, Dense → Thermal Radiation (Continuum)
Hot, Thin → Emission Lines
Cooler, Less Dense in front of Hotter, Denser →
Absorption Lines on Thermal Radiation

Stellar Spectra
Absorption Lines on Thermal Radiation
Stars hotter, denser inside

Spectral Types
O B A F G K M (hot to cool)

Single Stars: What can we learn?
Distance, Motion
Luminosity, Temperature, Radius
Composition, Rotation, Magnetic Field

Binary Stars
Visual, Spectroscopic, Eclipsing

Stellar Masses
Determine from binary stars
Mass vs. Luminosity

Laws of Motion
Mass, Volume, Density, Weight
Force and Acceleration
Force of Gravity

HR Diagram
Luminosity vs. Temperature
Main Sequence, Giants, Supergiants, White Dwarfs
Evolution or Intrinsic Differences?
How Stars Work
  Light only from outer edge
  Stars are long lived, Sun is 5 billion years old

Pressure balances Gravity (Hydrostatic Equilibrium)
  Central Temperature = 15 million degrees K for Sun

Large Energy Source Needed to Power Stars

Nuclear Energy
  Curve of Binding Energy
  Fission and Fusion
  Fusion is energy source for stars
  H Burning, He Burning, C Burning

Central Role of Nuclear Reactions
  Make stellar energy
  Allow stars to live long time
  Make heavy elements

Solar Neutrino Experiment
  Too few neutrinos detected
  Recent experiments → neutrinos have mass and oscillate

Theory of Stars
  Hydrostatic equilibrium
  Nuclear energy
  Heat flows outward via radiation and/or convection

Russell–Vogt Theorem
  Mass and composition determine stellar structure
  Main Sequence = stars with different masses, made mainly of hydrogen

Stellar Evolution
  HR Diagrams and Stellar Clusters

Aging of Stars
  Lifetime vs. Mass
  Main-Sequence = normal life, H burning in core
  Giant = H shell burning
  Horizontal Branch = He core burning, H shell
  Supergiant = H and He shells
  $M < 8 \, M_\odot$ stop with C core
  $M > 8 \, M_\odot$ stop with Fe core