Lecture 6 Notes: Stellar Classification and Populations

Summary Notes

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1 Translating Observations to Physical Parameters

1.1 Fundamental Relationships

- Flux-luminosity-distance relationship
- Temperature-color relationship
- Mass-luminosity relationship for main sequence stars
- Radius determination from temperature and luminosity

2 The Hertzsprung-Russell (HR) Diagram

2.1 Basic Properties

- Plots luminosity vs. temperature (or color)
- Fundamental tool in stellar astronomy
- Shows evolutionary state of stars
- Main features:
  - Main sequence
  - Giant branch
  - White dwarf sequence

2.2 Modern HR Diagrams

- Hipparcos data revolutionized stellar statistics
- Precise distances and luminosities
- Clear separation of different stellar populations
- Better understanding of stellar evolution paths

3 Stellar Mass

3.1 Importance

- Most important parameter for stellar evolution
- Determines:
  - Surface temperature
  - Radius
  - Luminosity
  - Evolutionary path
  - Final fate

4 Stellar Spectra

4.1 Basic Characteristics

- Approximated by blackbody radiation
- Modified by absorption and emission lines
- Temperature determines overall shape
- Chemical composition affects line strengths

5 Spectral Classification

5.1 Morgan-Keenan System

- Main sequence: O, B, A, F, G, K, M
- Temperature sequence (hot to cool)
- Subtypes 0-9 within each class
- Luminosity classes I-V

  - I: Supergiants
  - III: Giants
  - V: Main sequence

6 Stellar Populations

6.1 Population I Stars

- High metallicity ($Z \gtrsim 0.01$)
- Young stars
- Found in galactic disk
- Examples: Sun, open cluster stars
- Circular orbits around galactic center

6.2 Population II Stars

- Low metallicity ($Z \lesssim 0.01$)
- Old stars
- Found in galactic halo and globular clusters
- Highly elliptical orbits
- Examples: Stars in globular clusters

7 Variable Stars

7.1 Classification

- Intrinsic variables
  - Physical changes in star
  - Examples: Cepheids, RR Lyrae
- Extrinsic variables
  - Geometric effects
  - Examples: Eclipsing binaries

8 Modern Data from Gaia

8.1 Impact on Stellar Astronomy

- Precise astrometry for billions of stars
- Better understanding of stellar populations
- Improved HR diagrams
- Discovery of many variable stars

8.2 Gaia DR3 Statistics

- Over 1.8 billion sources
- Precise parallaxes and proper motions
- Photometry in multiple bands
- Radial velocities for bright stars

9 Key Concepts for Further Study

- Relationship between mass and other stellar parameters
- Population differences and galaxy evolution
- Role of metallicity in stellar evolution
- Importance of variable stars as distance indicators