Astrophysics
An Observational Science

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Outline

- Astrophysics as an observational rather than a purely experimental science
- Astrophysics as a science in which we are constantly being surprised by the observations
- Astrophysics at Michigan State University
- Astronomy and astrophysics as a field for student research projects

How is astrophysics different from other areas of physics?

It is an observational science rather than an experimental one

[Image of observatory and landscape]
In astronomy or astrophysics one is often not able to run controlled experiments

- There is only one universe to observe, and we can only observe it directly from a single point in time and space

Numerical experiments

- We can only observe this colliding pair of galaxies from one point in space and at one point in time
- We can, however, make numerical simulations to help us understand what is happening
Numerical Simulations

Laboratory astrophysics

- Laboratory experiments can help us to understand the physics behind astrophysics
- Example:
  Nuclear astrophysics at the National Superconducting Cyclotron
Astrophysical surprises

- Astrophysics has been driven as much by surprise discoveries as by theoretical predictions

The Accelerating Universe

- The expansion of the universe was discovered c. 1930

More distant galaxies have higher redshifts
Does gravity slow the expansion over time?

Measuring the expansion at large distances

- Astronomers needed to find a “standard candle” – an object of known brightness that could be seen to great distances
- By measuring a “brightness” distance to these objects and also measuring their redshift, it was thought that we would learn how the expansion of the universe was slowing over time
- Type Ia supernovae

Nobody expected an accelerating expansion

- But teams looking at distant supernovae found something strange
Accelerating Universe

- The universe’s expansion is accelerating
- Most of the energy density of the universe is “dark energy”

Astrophysics at Michigan State University

- Nuclear astrophysics
  - NSCL
- Theoretical astrophysics
- Observational astrophysics
  - SOAR
  - Campus Observatory
SOAR
A 4-meter telescope in the Andes

SOAR Remote Observing Room

• Observing with SOAR can be done remotely from the MSU campus
The SOAR partnership

- Brazil
- United States National Optical Astronomy Observatories
- The University of North Carolina
- Michigan State University

The Campus Observatory

- 60-cm reflecting telescope

Bright sky research

- What kind of research can we do at the campus observatory?
  - Bright sky (sometimes clouds!)
  - Designed to involve students
Variable star astronomy

- CCD – charge-couple device camera
- Student observers

Understanding the evolution of stars

- Pulsating giant stars
- Eclipsing binary stars
- Explosive stars
  - Novae
  - Supernovae

Light Curves of Pulsating Variable
Extragalactic supernovae

Astronomy is a field where amateurs still play a role in research
Planetary Astronomy

Other possible projects

• Measuring the rotation of asteroids from their brightness changes
• Determining the orbits of comets and asteroids
• Measuring the masses of planets by observing the motions of their moons
• Measuring the orbits of binary stars

Student papers

The Changing Amplitude of the [delta] Scuti Star AN Lyn


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THE CHANGING BRAGDON EFFECT OF X2 CVNS

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