Unit 3: OBSERVING VARIABLE STARS

Observing variable stars involves locating them within the constellation, learning how to estimate their changing magnitudes, and recording the information. Finding objects in the night sky depends upon our knowledge of the constellations. We use the constellations to identify celestial objects or events: the Leonid meteor shower, for example, seems to radiate from the constellation Leo; the Andromeda Galaxy is located within the Andromeda constellation; the Ring Nebula is found in the constellation Lyra. Variable stars are also located within constellations, though seldom as part of the prominent pattern or asterism. Chapter 5, "Introducing the Variable Star Astronomy Constellations," introduces five constellations that contain variable stars from the AAVSO International Database; Chapter 6, "Measuring Variable Stars Visually," utilizes VSA slides to help students learn the skill of estimating magnitudes; and Chapter 7, "Observing Stars in the Real Sky," is central to the Variable Star Astronomy curriculum—observing and recording magnitude changes of variable stars in the real sky.

CONTENTS FOR UNIT 3

Core Activity 6.5: Collecting Your Own Data
Poster Page: Who Are the Amateur Astronomers?
Core Activity 6.6: Magnitude Estimation and Graphing With Slides (and/or prints)
Space Talk on Visual vs. Photoelectric Observational Data

CHAPTER 7: OBSERVING VARIABLE STARS IN THE REAL SKY

This chapter is the core of the Variable Star Astronomy curriculum, introducing students to the process of variable star research. Students will be able to systematically observe bright variable stars such as delta Cephei and W Cygni.

Poster Page: Starlight In Your Eyes
Poster Page: Occupational Hazards of Variable Star Observing
Core Activity 7.1: Observing Your First Variable Star—Delta Cephei
Poster Page: She Discovered How to Calculate the Distances to Galaxies
Activity 7.2: Observing the Variable Stars W Cygni and Chi Cygni
Space Talk on Cepheids

Relationship to National Science Standards and Benchmarks:

The *National Science Standards* states that performing investigations in order to develop understanding, ability, values of inquiry, and knowledge of science content promotes inquiry learning. This unit is an application of the fundamental concepts which underlie the *Unifying Concepts and Processes* and *Science as Inquiry* Content Standards: observing, recording and analyzing data, and communicating the results. Both regularities and irregularities within systems produce patterns that are understandable and predictable. Some changes can be directly observed but not directly measured, and mathematics is the essential tool for measuring such changes. Mathematical calculations such as circumference, finding the mean, precision and significant figures, and comparing data for two groups by representing their averages and spreads graphically are all computation and estimation essentials listed in *Benchmarks.* The unifying concepts and processes emphasized within this chapter are *Evidence, Models, Explanation and Change, Constancy,* and *Measurement.* Past and present study of variable stars has contributed significantly to our fundamental understanding of the origin of the universe. Progress has come from both advances in technology and the contributions of professional and amateur astronomers from all walks of life. This unit shows how historical and current scientific knowledge each influence the use of prevailing technology, and how results are interpreted and evaluated.

Chapter 5: Introducing the Variable Star Astronomy Constellations

Summary

Five constellations are presented in this chapter: Auriga, Ursa Major, Cygnus, Cepheus, and Cassiopeia. Auriga is a winter constellation and Cygnus is a summer constellation, and the rest are circumpolar in the Northern Hemisphere. Students will investigate the stars and other celestial objects in these constellations. They will also learn about some of the mythologies associated with them.

Terminology

binary system	extrinsic variable	planetary nebula	stellar evolution
black dwarf	intrinsic variable	pulsating variable	supergiant
cataclysmic	nova	radiation pressure	supernova
eclipsing binary	optical double	red giant	white dwarf
eruptive variable	parallax	semiregular variable	

Common Misconceptions

1. *The stars within the constellations are the same distance from the Earth.*
2. *The constellation is only the prominent pattern of stars, or asterism, usually associated with the constellation.*

SUGGESTIONS FOR THE POSTER PAGES, INVESTIGATIONS, AND ACTIVITIES

Investigation 5.1: The Magnitude of Stars in a Constellation

Select one of the VSA slides for this activity. You may find it easiest to start with the "UMa #1" slide of the Big Dipper, followed by "Aur #1," "Cep #1," and "Cas #1." You may choose *not* to darken the room when showing the slides for the first time. This way, only the brightest stars are visible. This may make it easier for students who find the background scatter of stars distracting. Also, if your students live in areas with lots of light pollution, the slide will more closely represent what they actually see in the sky. Another way to reduce the background clutter of stars on the slides is to mask the projector lens with an "iris" made from an index card in which you have punched a hole. If any of your students are undecided about the ranking of magnitudes, then slightly blur the focus of the slide—you can then more clearly see the brightness of the stars that seem to be of the same magnitude. You may elect to have the students address more than one of these slides, depending upon their skill level.

Poster Page: How Do You Keep Track of the Stars? (Star Catalogues)

The history of star catalogues is interesting, from the earliest catalogue to the most recent. What stars were included? What information was given about them? How were their positions determined? How were their magnitudes determined? How many stars were recorded in each successive catalogue? Who produced the catalogues? How does the number of recorded stars correspond to the development and availability of technological instruments? Were there bad catalogues? How do we keep track of the positions of stars today? What organizations are responsible? What is the purpose of star catalogues? Why is it important to know exactly where a star is located?

Investigations 5.2–5.6

These activities are a brief presentation of some of the mythologies associated with the VSA constellations. Show the corresponding slide for each activity. The variable stars listed below are the same variable stars that the students plotted in Core Activity 4.5. Using the finder charts, see if your students can locate the variable stars on the slides, or at least find their general vicinity. In case your students have difficulty locating the constellation patterns on the slides, we have included with this manual a set of finder slides, on which the constellation outlines, some of the variables, and other major stars have been indicated. You may use these at your discretion to assist your students. (The finder slides are reproduced on the following six pages.)

Auriga—R Aur

Ursa Major—R UMa, S UMa, Z UMa

Cygnus—χ (chi) Cyg, W Cyg

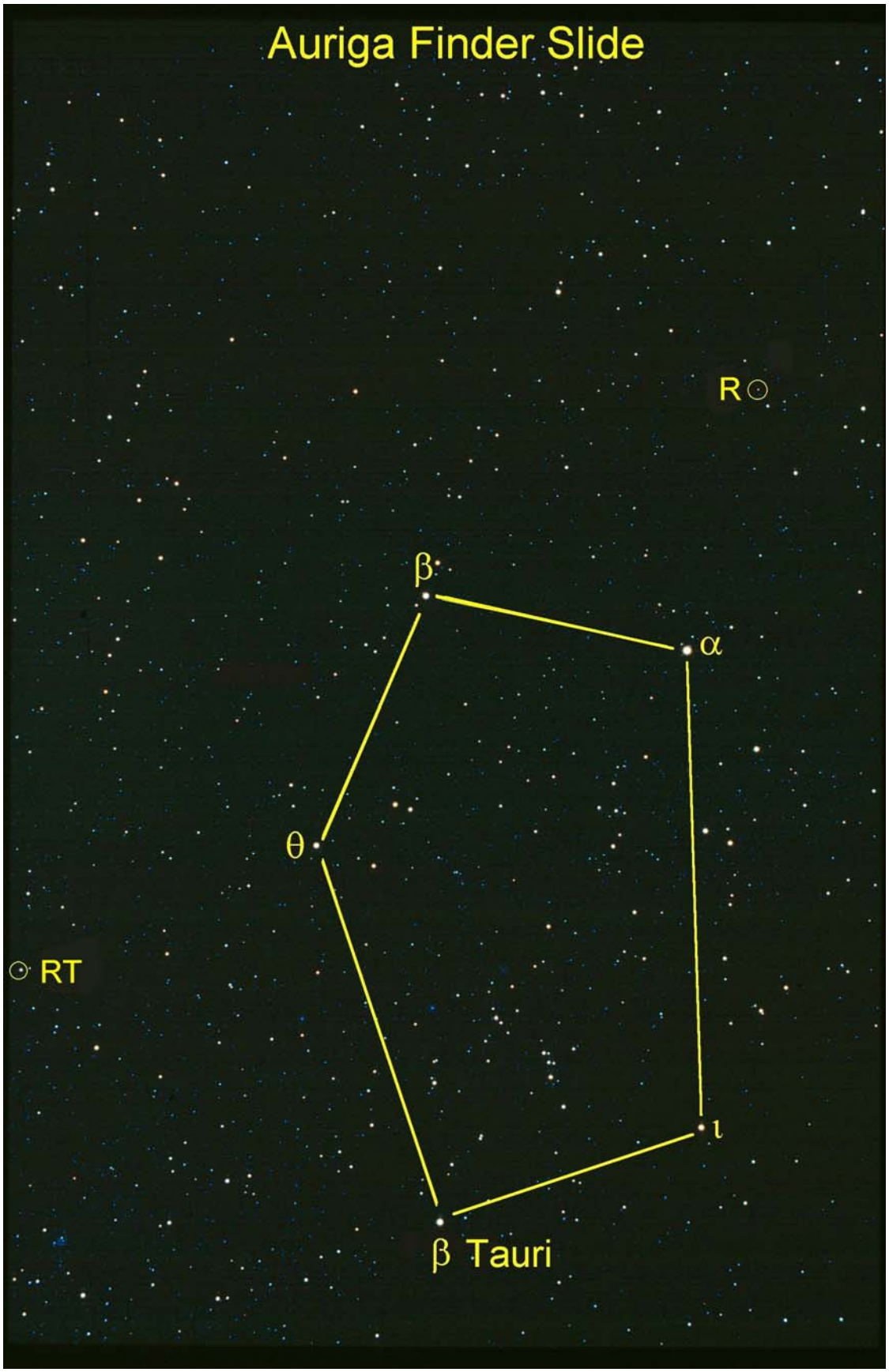
Cepheus—T Cep, S Cep

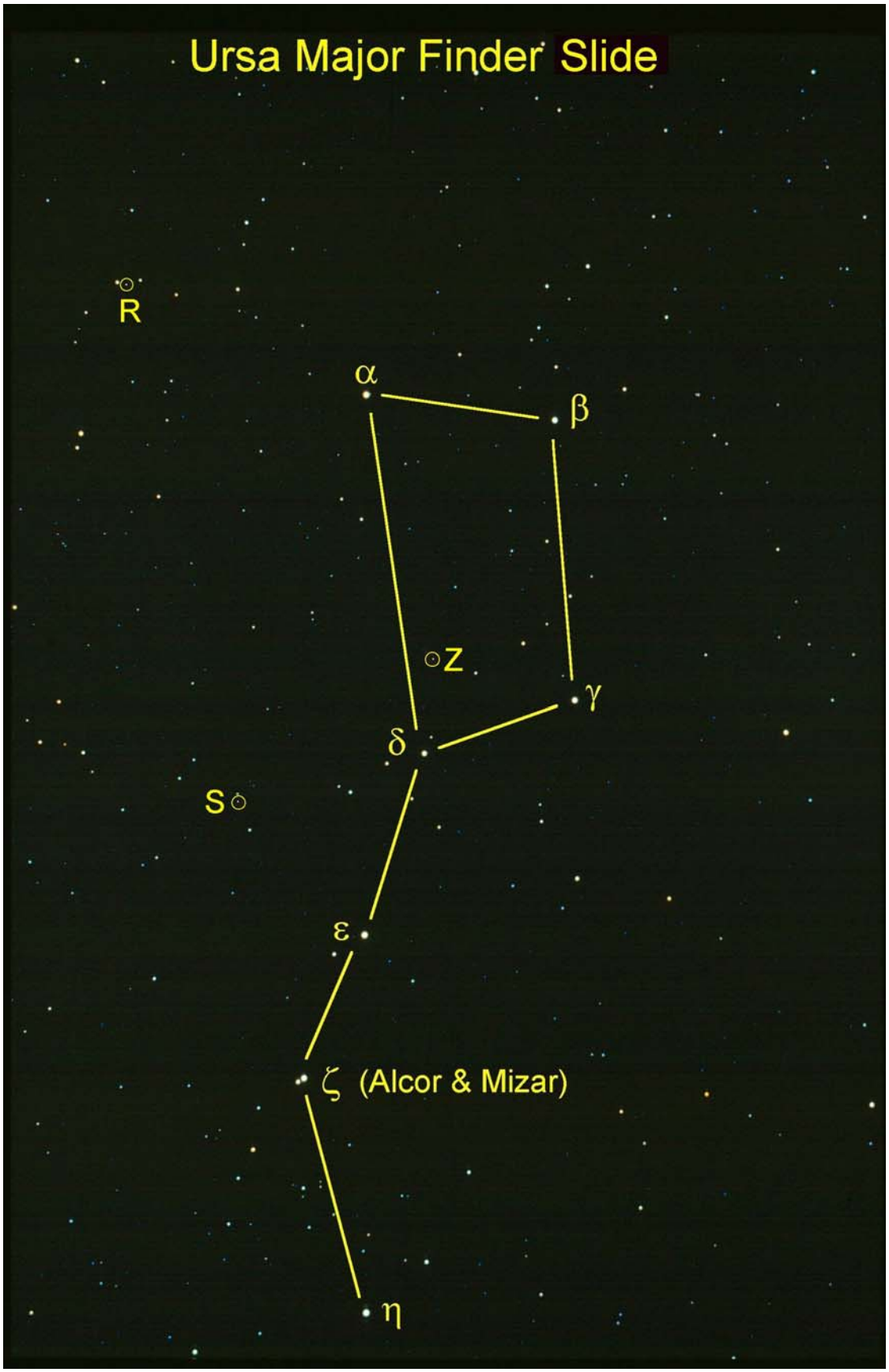
Cassiopeia—R Cas, V Cas

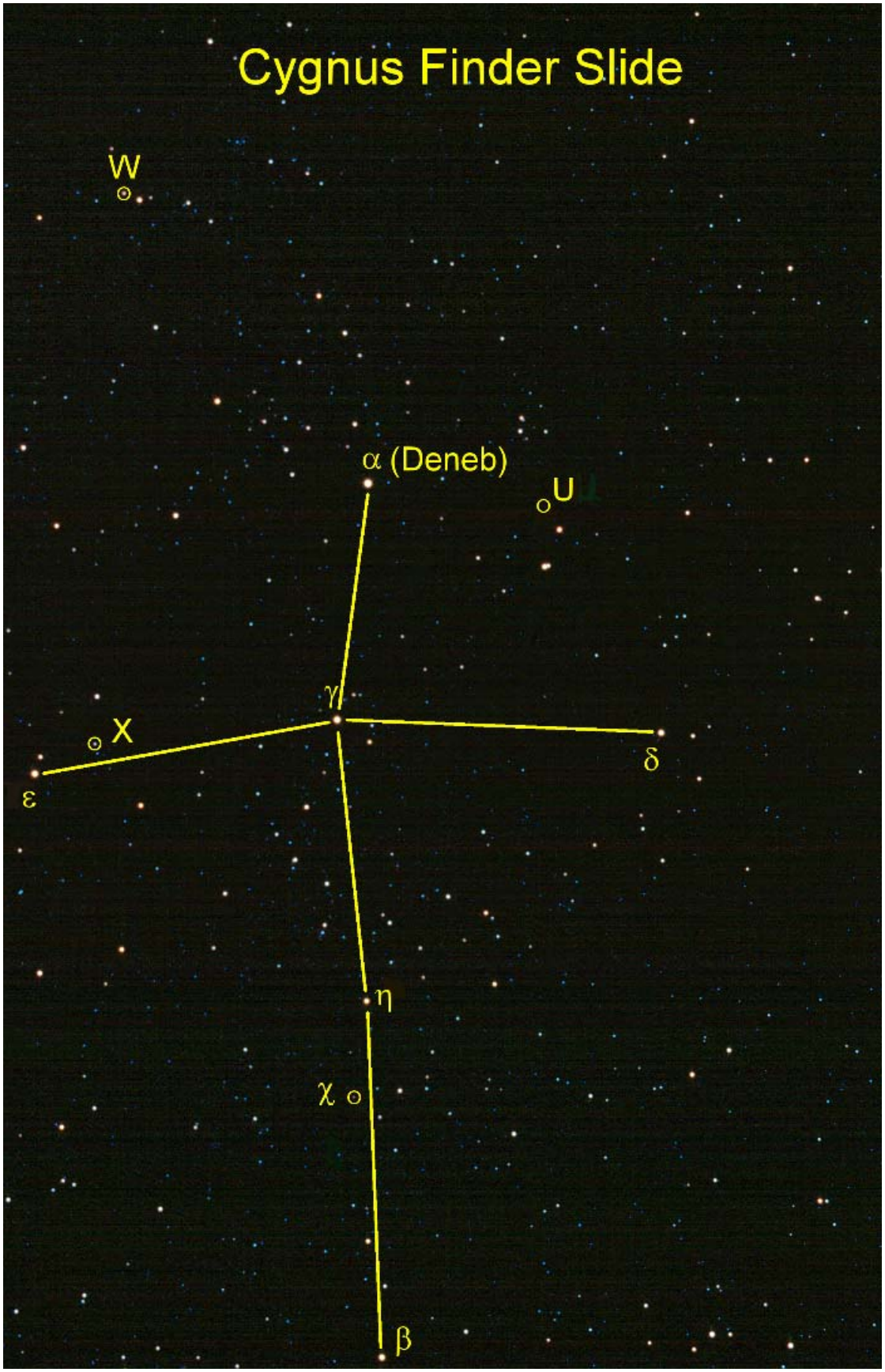
There are also several interesting deep sky objects within the constellations which cannot be visually detected. However, these objects are listed as points of interest in the student section. You may wish to obtain a slide set of deep sky objects so you can show them along with the VSA slides. (See details in the Resource List.)

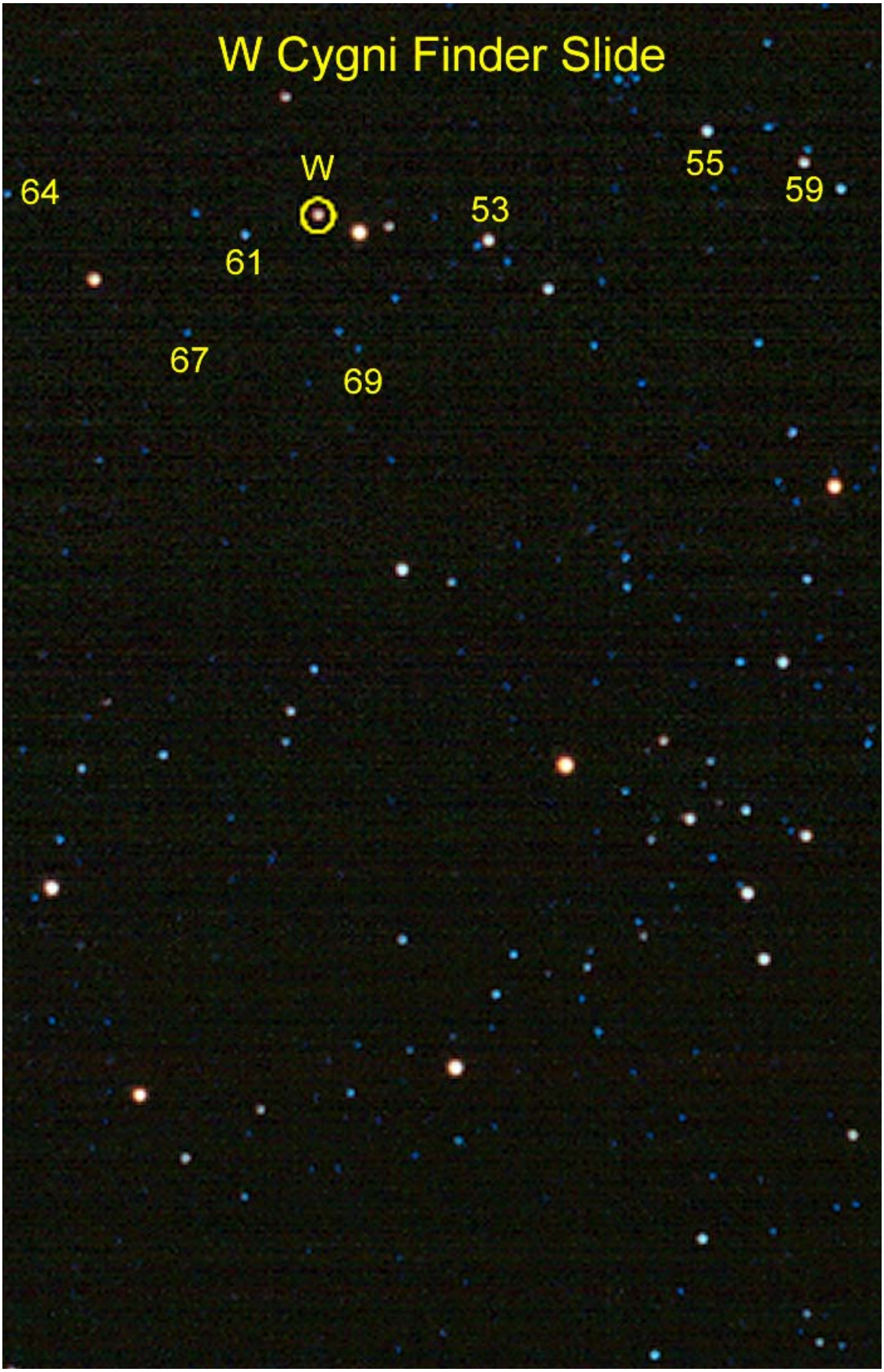
RESOURCE

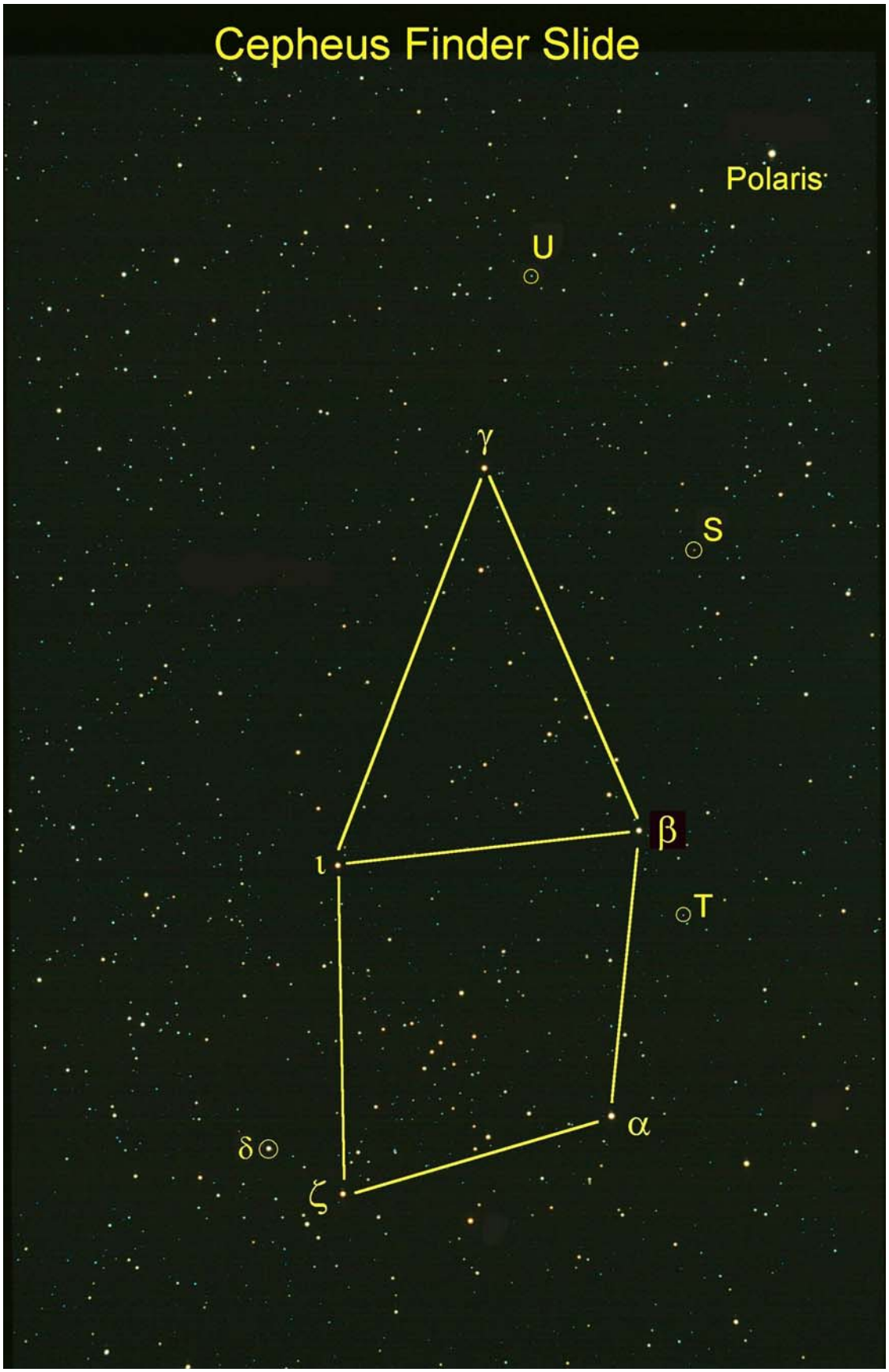
The concept of parallax is introduced on page 82 of the student section. A more detailed explanation is found in Poster Page 11.1.

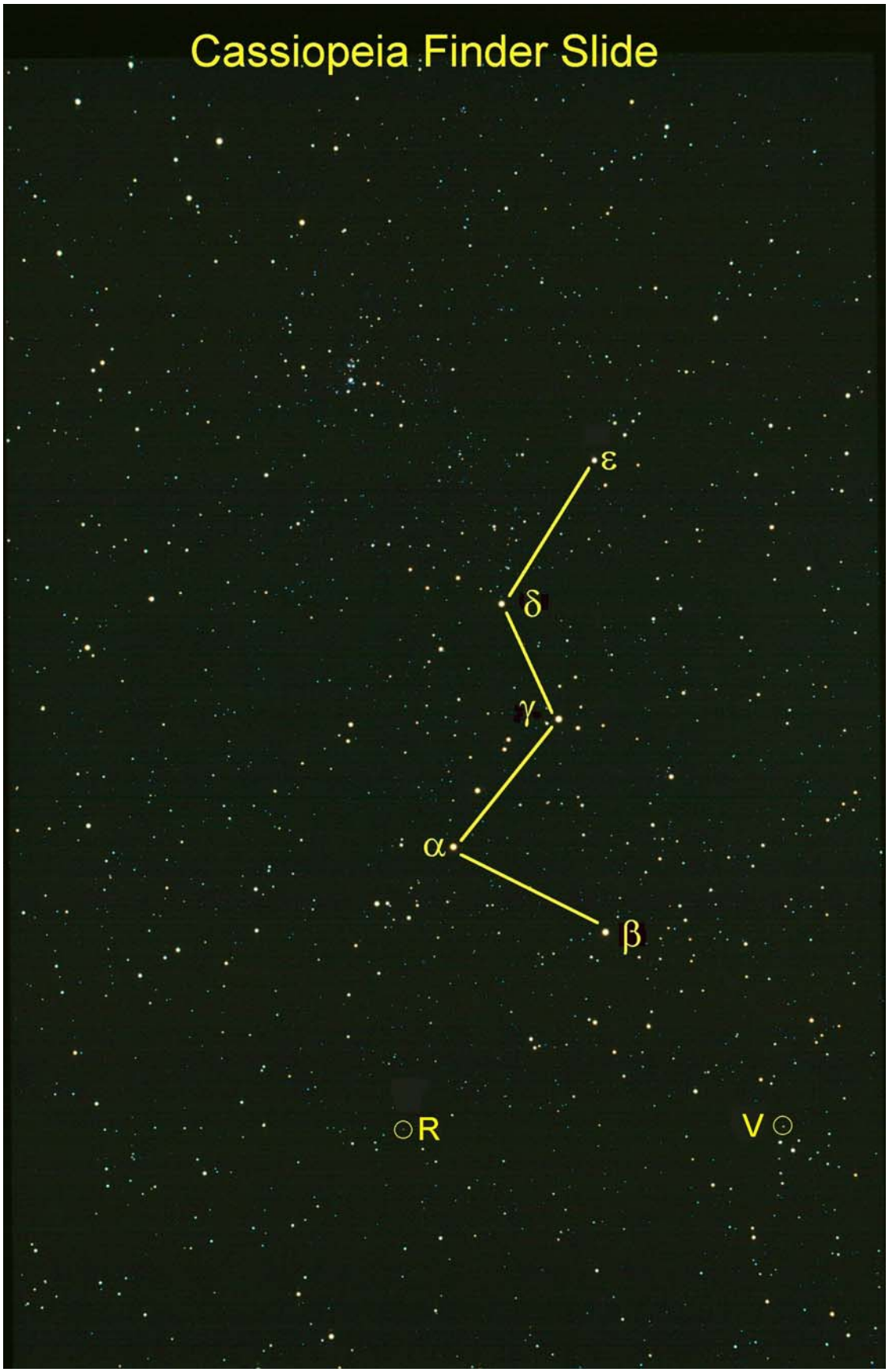

Auriga Finder Slide
R⊙
β
α
θ
⊙ RT
ι
β Tauri


Ursa Major Finder Slide
R
α
β
Z
γ
δ
S
ε
ζ (Alcor & Mizar)
η


Cygnus Finder Slide
W
α (Deneb)
U
γ
X
ε
δ
η
χ
β


W Cygni Finder Slide
W
64
61
53
55
59
67
69


Cepheus Finder Slide
Polaris
U
γ
S
β
ι
T
δ
α
ζ


Cassiopeia Finder Slide
ε
δ
γ
α
β
R
V

Poster Page: Astronomy is for Everybody (the AAVSO)

The AAVSO is not the only organization in the world with a variable star database. Other organizations around the world have databases. Some are specialized, keeping only eclipsing binary observational data, for instance. Do countries exchange information? Do organizations exchange information? How active are variable star observers in Germany? Russia? China? France? England? What types of professional organizations utilize the AAVSO International Database? What do they utilize the information for? In later chapters you will be introduced to HIPPARCOS; what other satellites make use of contributions from amateur variable star observers?