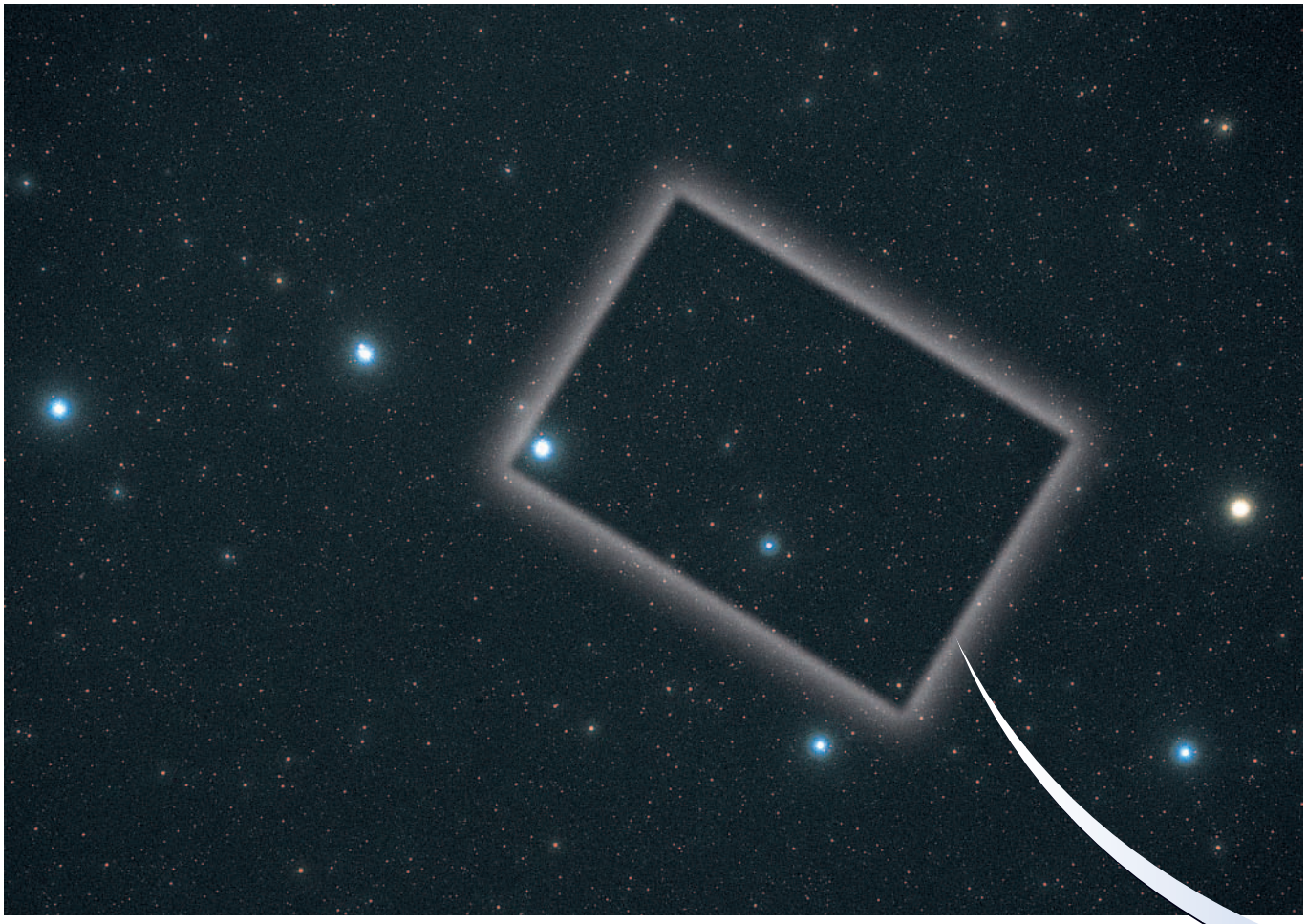


Big Dipper Variables

Near where the Dipper's Handle joins the Bowl are six variable stars that you can check with binoculars. | **By John E. Isles**

Everyone knows the Big Dipper, or the Plough as it's called in England. On spring evenings it hangs nearly overhead as seen from midnorthern latitudes. Users of small telescopes know it mainly for its bright double star, Mizar, and its scattering of Messier objects, mostly galaxies. But the Big Dipper also hosts a collection of interesting variable stars near where its handle joins the bowl.

The joining point is the star Megrez, Delta (δ) Ursae Majoris, the faintest of the Dipper's seven stars (at magnitude 3.3). Megrez itself has been suspected of being a "secular variable," changing brightness over the centuries. Has it indeed faded from a time of former glory?

In his *Uranometria* star atlas, published in 1603, Johann Bayer marked the Big Dipper's stars with the first seven letters of the Greek alphabet in order from west to east. This is obviously not their order of brightness today. In fact Delta is fainter than Theta, Iota, Mu, and Psi Ursae Majoris, which are not even part of the Dipper. But contrary to some popular belief, this means nothing. Bayer rarely labeled a constellation's stars in strict order of brightness. Instead, his method was usually to name the brightest star Alpha, then to group stars into very broad brightness classes and assign letters within each class in order from the head to the feet of the traditional constellation figure. The fact that he labeled Megrez Delta does not suggest that he saw it as the fourth-brightest star in the constellation.

An anomaly remains, however, in that Tycho Brahe in the 16th century called Megrez 2nd magnitude. Agnes Mary Clerke, in her influential 1903 book *Problems in Astrophysics*, concluded that Delta had "undeniably faded with the lapse of centuries." Elsewhere she wrote, "The immemorially observed constituents of the Plough preserve no fixed order of relative brilliancy, now one, now another of the septet having at sundry epochs assumed the primacy." That seems like a wild conjecture. Ptolemy's star catalog, apparently based mainly on observations by Hipparchus some 2,100 years ago, listed Delta as magnitude 3 and the other six stars as magnitude 2, the same as they are today.

Modern measurements find no significant variability in Delta Ursae Majoris.

Nor are any other stars of the Big Dipper recognized as variable, with the exception of Epsilon (ε), which has a tiny range of two hundredths of a magnitude.

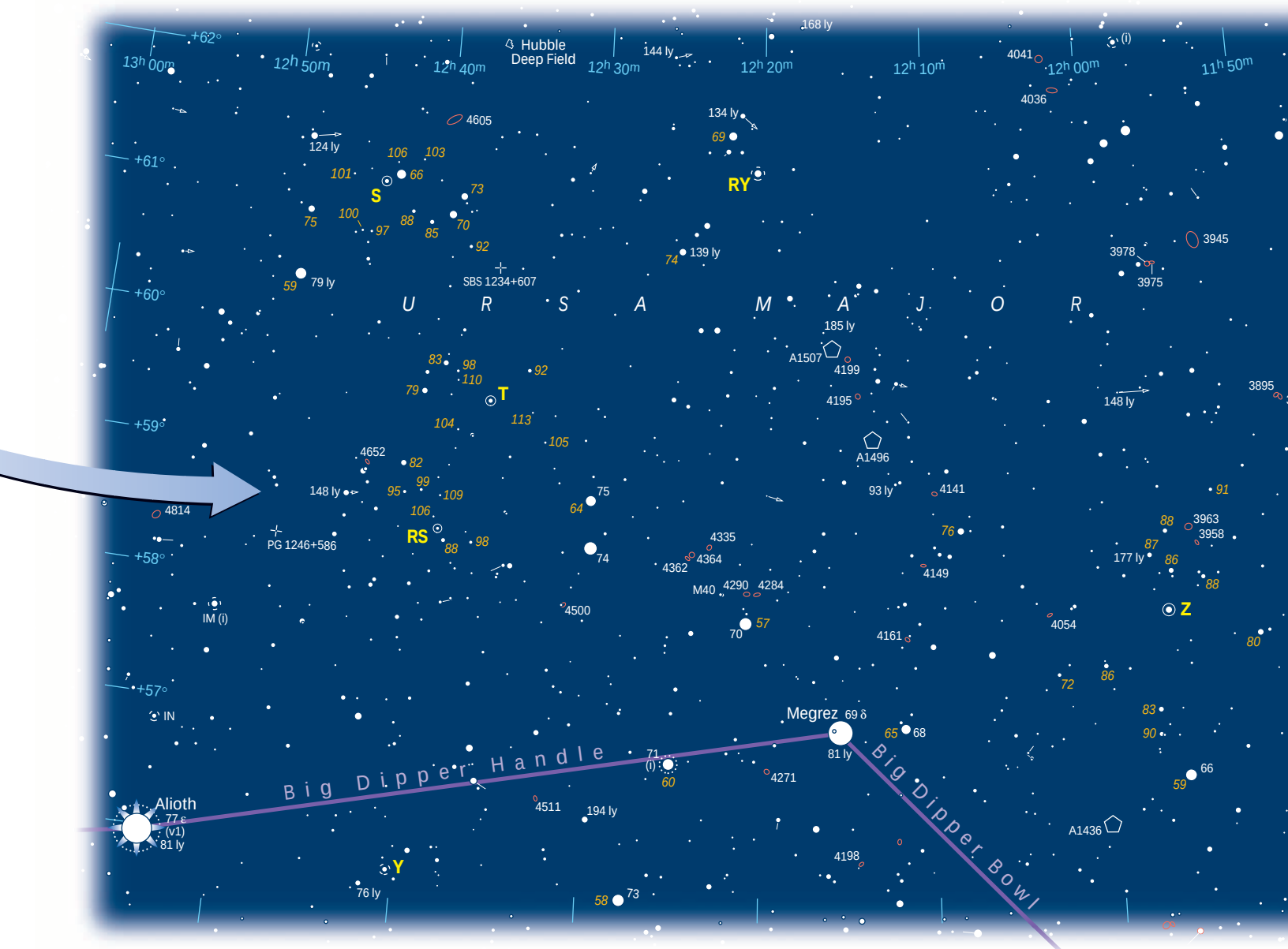
Binoculars and small telescopes, however, can reveal several variable stars in the region surrounding Megrez. Here are six that you can look at whenever the Big Dipper is in view.

S Ursae Majoris, a Mira-type long-period variable, is a red giant of the uncommon spectral class *S*. Its spectrum displays bands of zirconium oxide and cerium oxide as well as lines of neutral technetium, an unstable element that was thought to be created only in nuclear laboratories until it was discovered in the spectra of *S* stars. Presumably it is circulating up from the star's reactive core.

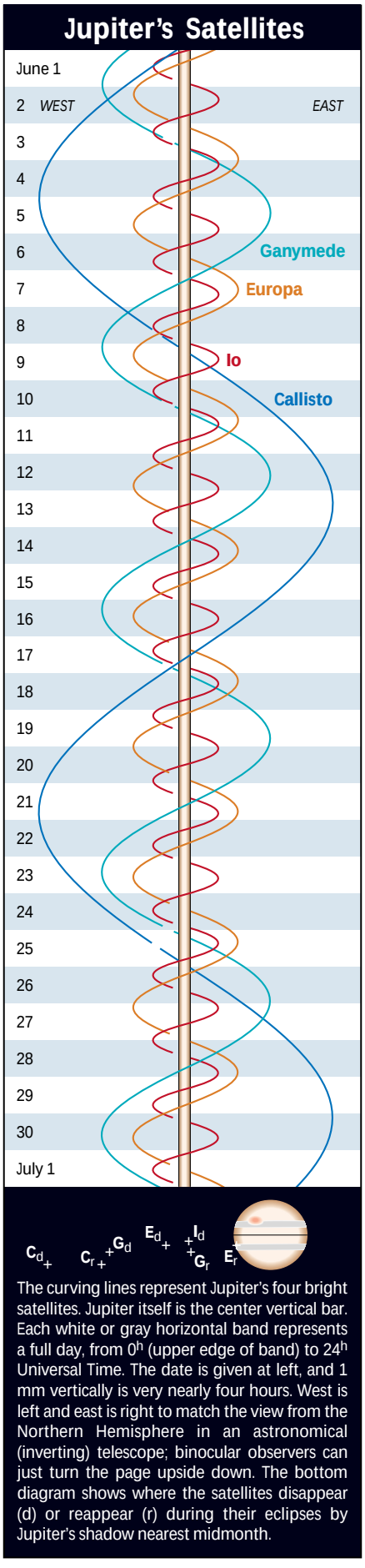
S UMa is expected to reach maximum light in mid-May. It normally ranges from magnitude 12 to 8, but it has been recorded as bright as 7.1. Its period averages 226 days with appreciable deviations. The star's changing light was discovered in 1853 by the English astronomer Norman Pogson at Radcliffe Observatory, Oxford.

T Ursae Majoris is one of the more normal, *M*-type Miras, which show bands of titanium oxide in their spectra. It was discovered in 1860 at Bonn Observatory, Germany, by observers compiling the *Bonner Durchmusterung* star catalog. T is currently faint but on the rise; it should peak in mid-July. It normally ranges between magnitudes 13 and 7.7 with a period of 257 days, but its peaks can be as bright as 6.6 or as faint as 9. If you have a dark sky you may find both S and T UMa visible in binoculars at the same time for several weeks in late spring and early summer this year.

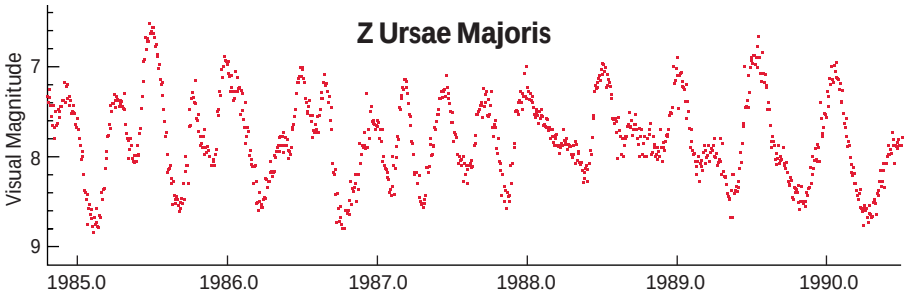
RS Ursae Majoris is another *M*-type Mira with a very similar period, 259 days. It's somewhat fainter, usually ranging from magnitude 14 to 9, though it has occasionally been as bright as 8. Its



The star field around Megrez in the Big Dipper (lower center). Six variable stars are labeled in yellow; comparison stars around them have magnitudes (courtesy AAVSO) printed in orange with the decimal point omitted. This chart is heavily adapted from pieces of six charts in the *Millennium Star Atlas.* The composite chart was reduced in size to fit the page, then all star dots were enlarged for clarity. A unique feature of the *Millennium* atlas is its inclusion of distances to all stars that the Hipparcos satellite measured to be closer than 200 light-years. That far away, the Hipparcos distances are typically accurate to 6 percent.



The curving lines represent Jupiter's four bright satellites. Jupiter itself is the center vertical bar. Each white or gray horizontal band represents a full day, from 0^h (upper edge of band) to 24^h Universal Time. The date is given at left, and 1 mm vertically is very nearly four hours. West is left and east is right to match the view from the Northern Hemisphere in an astronomical (inverting) telescope; binocular observers can just turn the page upside down. The bottom diagram shows where the satellites disappear (d) or reappear (r) during their eclipses by Jupiter's shadow nearest midmonth.



The light curve of Z Ursae Majoris from November 1984 through June 1990. Each point is a 2-day mean of amateurs' visual observations in the AAVSO International Database. Note the star's semiregular behavior, which probably results from the superposition of several different pulsation periods.

maximum is due around May 20th, so this star too merits a binocular check.

Z Ursae Majoris is always worth observing with binoculars. It's a semiregular variable nearly 3° west-northwest of Megrez. Many semiregular variables have rather small ranges and thus don't offer much for visual observers. But Z UMa is different. Discovered on Harvard College Observatory sky-patrol plates taken from 1897 to 1904, it has a range of at least two magnitudes — and sometimes has been as bright as 6.2 and as faint as 9.4, according to the official *General Catalogue of Variable Stars.* Moreover, the star has a complicated light curve that seems to result from the superposition of several different cycles.

From 1943 to 1948 the variations seemed to be completely irregular. More typically Z UMa shows deep minima about every 196 days, when the star falls nearly to magnitude 9. Between these deep minima are often two maxima, and occasionally three or four, separated by shallow minima — suggesting the presence of a shorter, less regular cycle of 60 to 90 days. From mid-1989 through the end of 1991 the star swung back and forth directly from its brightest maxima to deepest minima.

Other periods have been reported, including one of 203 days causing slow fluctuation patterns or "beats" in the main variation, and a very long cycle of several years slowly changing Z UMa's mean magnitude. A recent study that applied Fourier analysis to 18 years of visual magnitude estimates by Hungarian amateurs gave rather different results, indicating the simultaneous presence of periods 97, 99, 101, 195, and 5,680 days long. Some of these apparent periods seem to be only transient. They could be produced by complex pulsations in the star's atmosphere, possibly compounded by rotation and some kind of starspot cycle. But some of the reported periods may just be artifacts of the analysis method, owing to the use of short runs of data.

RY Ursae Majoris, a little more than 4° north of Megrez, is another semiregular red giant with a smaller range, normally 7.0–8.2 in a cycle of about 10 months. Rather fainter is **Y Ursae Majoris** almost 4° east-southeast of Megrez, with a range of 7.7–9.8 and a period of five or six months.

Hundreds of variable stars like these are visible in binoculars. Many have been on the observing program of the American Association of Variable Star Observers (AAVSO) for decades. To make reliable magnitude estimates using binoculars, it is important to hold them steady. A good way to do this, especially when aiming high in the sky, is to lie on your back and rest your arms on your chest.

The AAVSO welcomes magnitude estimates of these variables as judged by the comparison stars marked on the chart. The comparisons' magnitudes are labeled in orange. Charts showing fainter comparison stars for use with larger instruments are available from the AAVSO. New observers, especially those who expect to make variable-star observing a long-term project, are always sought. For a beginner's information kit and other materials, write to the AAVSO at 25 Birch St., Cambridge, MA 02138, send e-mail to aavso@aavso.org, or view its World Wide Web site at http://www.aavso.org/.

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