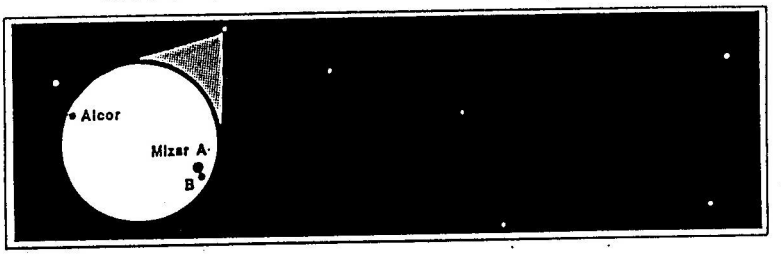
"See the Double-Double-Double in the Big Dipper ?!"



JOURNEY TO MIZAR

A Closer Look at a Famous Double Star

by J. Timothy Unruh, Copyright © 1994

A casual gaze skyward on any clear dark night will disclose a stellar multitude of what appears to be solitary points of light. Yet, through the magnifying eye of an astronomical telescope it will be found that many of these stars can be "split" into a plurality of components. Such objects were initially referred to simply as "double" stars and were all thought to be the result of chance alignments of stars at varying distances along the same line of sight as seen from Earth.

Double stars have been a subject of great interest to astronomers since the Italian astronomer Giovanni Battista Riccioli, in the year 1650, discovered that Zeta (ζ) Ursae Majoris (Mizar) located at the bend in the handle of the Big Dipper is a telescopic double star. Soon after, other stars were found to be double or multiple including Theta (θ) Orionis - the Trapezium, and Alpha (α) Centauri - the closest star to the Sun. It was William Herschel who in his attempts to measure stellar distances confirmed in 1804 that most double stars were in fact gravitationally related objects rather than coincidental alignments. The Earth-Moon system can be seen as a counterpart to a double star.

Stars composing of two or more gravitationally bound components have come to be known as "binary" stars. There are at least 40,000 of these catalogued and it is now recognized that such stars represent a sizable portion of the total stellar population. The distances separating components of binary star systems vary greatly, ranging from a few million miles for some close spectrographic binaries to many billions of miles for widely separated telescopic binaries, yet because of the enormous distance of these stars from the Earth they appear visually as solitary objects. The orbital periods of binaries appears to range from a few hours to many centuries.

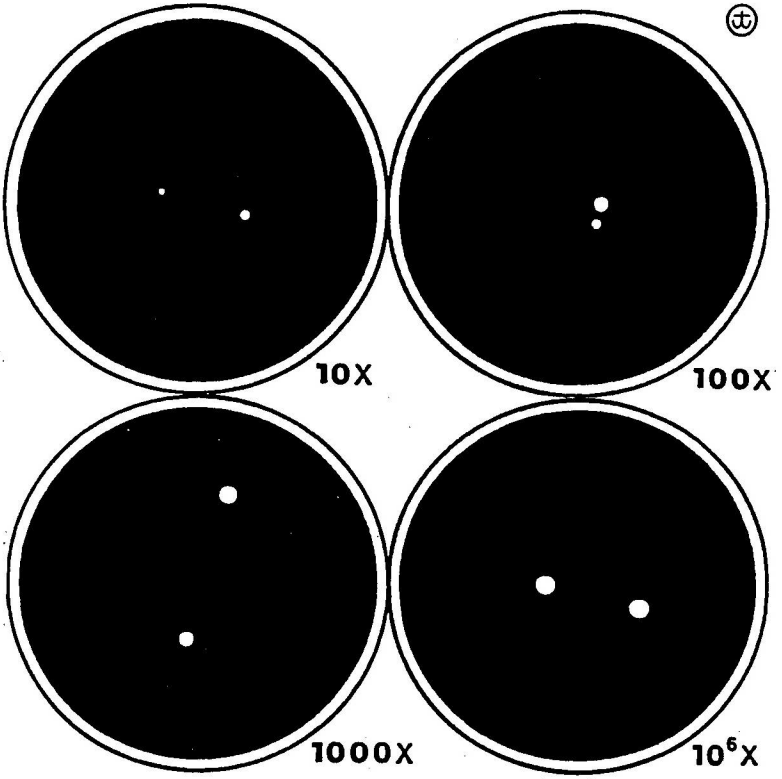
Perhaps the best known of all double stars is the celebrated Mizar in the familiar Big Dipper. Mizar conveniently illustrates several types of doubles. First of all it forms a naked-eye or optical double with its fourth magnitude neighbor Alcor which is about a fifth of a degree away to the east. The Arabs referred to this pair as the "horse and rider" with the rider traditionally considered a good test for the unaided eye. Secondly, Mizar (Mizar "A") is a telescopic binary with its companion (Mizar "B") just 14 arc seconds away to the south. Thirdly, Mizar A has a companion star too close to itself to be resolved by any earthbound telescope. This very close companion was detected in 1889 by Edward C. Pickering with the use of a spectroscope. In 1908 it was found that Mizar B as well as Alcor itself are also spectrographic binaries. Thus the Mizar configuration is essentially a triple star system including one close co-orbiting pair revolving around another close co-orbiting pair and the Alcor system. Although Alcor is not directly bound gravitationally as such to Mizar it is loosely associated with Mizar as one of about two dozen other scattered stars that form the Ursae Major moving cluster traveling together through space not unlike a flock of wild geese.

Many amateur astronomers enjoy using their telescopes to locate and observe some of the thousands of binary and multiple stars known. Resolving a binary, especially a close pair, is a good way to test the optical quality of a telescope, provided that the "seeing" quality of the atmosphere is good. Many binary stars have brilliant or contrasting

colors and are just plain pretty to look at. Albireo in Cygnus has a distinctly bluish and a distinctly goldish component. Mizar A and B have been described as "brilliant white and pale emerald".

The illustration A TELESCOPIC "ZOOM-IN" ON MIZAR depicts, as it were, a zoom-in sequence or "journey" into the Mizar system for a closer look. The illustration shows how the components might be ultimately split if it were possible to obtain the telescopic magnification indicated, at the upper end. This information is based on what is currently known about Mizar. As viewed from 12 inches away (typical reading distance), the illustration shows how the progressive separations of Mizar's components might appear in a telescope at the various magnifications given. At 10-power Mizar is clearly seen as an optical double with fainter Alcor to its left. The angular separation of these two is roughly equal to one third of the Moon's diameter as viewed from Earth. The actual separation between Alcor and Mizar is about one quarter of a light year. Both are 88 light years from Earth. At 100-power Mizar itself is easily split into its components, Mizar A, and Mizar B. They are 14.4 arc seconds apart; the actual separation is about 380 times the distance between the Sun and Earth, or about five times the diameter of the solar system. Reportedly, the two combined are 70 times more luminous than the Sun. At 1,000-power the spectrographic companions of Mizar A and B are still indiscernible. It would require a magnification of at least 150,000-power to visually split Mizar A into its two elements as efficiently as 100-power splits Mizar itself into the A and B components. The spectrographic companion of Mizar B has an orbital period of about one-half year. Astrometric analyses indicate a third component of the B system with a period of 1350 days. At 1,000,000-power, if that were possible, Mizar A is clearly split into its two selfsame components each of which is calculated to be at least 30 times more luminous than the Sun. Their period of revolution is a little over 20 days. Their angular separation is less than one one-hundredth of an arc second while their actual mean separation is about one half the radius of Mercury's orbit. The orbital eccentricity of the two is quite large at .54. If we could look

yet closer we might even see smaller components, possibly planets, amidst the stars of Mizar!



A TELESCOPIC "ZOOM-IN" ON MIZAR

Certainly, much lies beyond the probings of the amateur astronomer and his telescope, yet at the same time what is known by other means about such objects as Mizar can serve to enhance the appreciation and enjoyment of what the observer can indeed see through the eyepiece. The importance of binary stars to astronomy is that they make possible, assuming Newtonian physics, the determination of stellar masses and demonstrate the fact that the effects of gravity are not

confined to the vicinity of the Earth. Herschel realized that his discovery was much more important than his original pursuit of measuring stellar distances illustrating that unexpected results can derive from more mundane research. Herschel reportedly likened himself to Saul who went out to find his father's mules and discovered a new kingdom!

"It is He alone which commandeth the sun, and it riseth not; and sealeth up the stars. Which alone spreadeth out the heavens, and treadeth upon the waves of the sea. Which maketh Arcturus, Orion, and the Pleiades, and the chambers of the south."
Job 9:7-9