Catching Polaris during a quick-change act

Even a star as familiar as Polaris – the Pole Star – can produce surprises. Long known as a pulsating star that dims and then brightens approximately every four days, Polaris now appears to be changing rapidly to one whose brightness remains constant. This discovery provides a useful check on theoretical models of a star's interior, which predict how, when and why a star pulsates.

Because of its unique position very close to the north celestial pole, Polaris has attracted more attention over the years than other stars of comparable brightness. Classified as a Cepheid variable, it is a supergiant star about 500 to 800 light-years from Earth. As part of a binary star system, it also feels the tug of a small, invisible companion.

The combination of all these motions shifts the positions of spectral lines in the light emitted by the star. By monitoring these shifts, astronomers can deduce how rapidly Polaris pulsates and characterize its binary orbit.

The latest observations, which apparently point to the cessation of pulsations within a few years, result from a student project begun in 1987 by Nadine Dinshaw at the University of British Columbia in Vancouver. Using a small, 16-inch telescope equipped with a sophisticated electronic spectrometer, Dinshaw obtained 237 spectra of Polaris over a period of eight months.

Analysis of these spectra by Dinshaw, Jaymie M. Matthews, Gordon A.H. Walker and others at the university confirmed earlier indications that the four-day pulsation period is slowly lengthening. The results also established that this decline is occurring gradually rather than by abrupt jumps.

"This is quite consistent with what models of a star like Polaris . . . would predict," says Matthews. Just as a bell's pitch gets lower as the bell gets larger, the vibrations of a "ringing" star gradually slow as the star ages, cools and expands.

More surprisingly, the pulsations themselves – even as they slow down – now appear to be fading away. Historical data show that the amplitude of the pulsations remained constant from 1896 until at least 1956. But data collected since 1980 show a sharp decline in the amplitude of the brightness changes. Now the changes in brightness are barely discernible in a small telescope.

This drop in amplitude suggests that conditions within Polaris may have changed so that internal activity no longer drives the pulsations. Theoretical models of how long it takes pulsations to decay away after the driving force stops predict that pulsations should disappear in 10 to 20 years.

"Here's a star that may be evolving out of its phase of pulsational instability," Matthews says.

The trouble with this interpretation is that Cepheids spend 40,000 years or more in an unstable, pulsating phase, so the probability of catching a star right at the transition, which lasts only a short time, seems extremely small. Nonetheless, "this seems to be the most logical interpretation," Matthews says.

Recent measurements made by Matthews using a larger telescope at the Dominion Astrophysical Observatory in Victoria, British Columbia, show that the amplitude has continued to decline. "It's dropping ever faster," he says. That also makes the pulsations increasingly difficult to detect.

"If one were to extrapolate the data, the [amplitude] could drop to zero any time in the next few years," Matthews says. "So far, it's right on track."

The analysis of Dinshaw's initial observations also indicates the presence of a mysterious, 45-day cycle in the data, which may correspond to the motion of a large, surprisingly long-lived starspot or to a patch on the star's surface. "We're probably seeing the rotation of Polaris," Matthews says. The analysis also established that Polaris and its invisible partner complete an orbit in 29.9 years.

"What's remarkable is that the more closely we look at the nearby stars, the less normal does any of them appear," says Walker, who suggested to Dinshaw the idea of observing Polaris. "Here's an example of something that was just waiting to be found, and there are probably lots of other things like this."

Adds Matthews, "It's a good example of what interesting, possibly important science can be done with a small telescope."

– I. Peterson

Defensiveness reaps psychiatric benefits

Defensiveness has taken a bad rap. That, at least, is the implication of a report in the May AMERICAN JOURNAL OF PSYCHIATRY, which suggests defensiveness – the tendency not to report unfavorable information about oneself – is a protective trait against such psychiatric disorders as depression, anxiety and substance abuse.

"The monolithic view that mental health always involves opening up to, rather than avoiding, emotions and impulses is not supported by our data," says study director Richard D. Lane of the University of Arizona Health Sciences Center in Tucson.

Lane and his colleagues conducted interviews with 98 individuals. Half suffered from severe depression, while the rest had no psychiatric diagnoses. The researchers also interviewed 282 spouses and first-degree relatives of the study participants. To further check psychiatric histories, the team reviewed medical records for all 380 individuals and, when possible, contacted friends and relatives.

Each participant also completed a 33-item true/false questionnaire designed to gauge defensiveness. A response of "false" to some items, such as "I am sometimes irritated by people who ask favors of me," indicates denial of unpleasant emotions and counts toward greater defensiveness. A "true" response to others, such as "No matter who I'm talking to, I am always a good listener," also increases the defensiveness score.

Overall, subjects with high defensiveness scores had a significantly lower lifetime history of psychiatric disorders. People scoring low on defensiveness more often had met diagnostic criteria for severe depression, pervasive anxiety, drug abuse or alcoholism at some time during their lives.

Several pieces of evidence suggest defensiveness protects against psychiatric disorders, rather than merely reflecting an underreporting of psychiatric symptoms by people intent on denying "socially undesirable" characteristics, Lane and his co-workers assert. First, the statistical relationship between defensiveness and mental health held up when the team made psychiatric diagnoses by consulting an individual's close relatives and medical records. Second, the defensiveness-mental health pattern was strongest for the initial 98 depressed and nondepressed subjects, whose diagnoses had been meticulously established on several occasions as part of a separate study.

Also, the association between high defensiveness and mental health was greater among those at higher risk for developing mental disturbances. Relatives of depressed subjects are a known high-risk group, but those in the sample with no psychiatric history rated significantly more defensive than those who did have a history of mental disturbance. The same trend did not show up among relatives of subjects without depression.

There may be a physiological trade-off for the psychiatric benefits linked to defensiveness, the investigators note. Research conducted by study coauthor Gary E. Schwartz of Yale University has linked high defensiveness to increased risks of hypertension, breast cancer and elevated heart rate in response to stressful stimuli.

Further studies must establish whether low defensiveness is strongly associated only with certain categories of psychiatric disorder, or is linked to mental disturbances in general, the researchers point out.

– B. Bower