Long-Term Brightness Changes in Cool Pulsating Variables

John R. Percy

Erindale Campus, University of Toronto, Mississauga, Ontario, Canada L5L 1C6

Abstract

Several types of cool pulsating variables show unexplained long-term changes in brightness, typically on time scales of 10 to 20 times the basic (pulsational) period. The visual and photoelectric programs of the American Association of Variable Star Observers (AAVSO) are well-suited for detecting and studying these changes. Some examples are given here, including yellow hypergiants, RV Tauri stars, small- and large-amplitude red giant and supergiant variables. The study of pulsating variables on long time scales provides "new perspectives" on their behavior.

Yellow hypergiants such as rho Cas and V509 Cas show complex pulsational variations on time scales of about a year. There are also variations on a time scale of a decade or more, which appear to be connected with the expansion of the photosphere and/or the ejection of a shell (Zsoldos and Percy 1991; Percy and Zsoldos 1992). These observations, especially when combined with the long-term spectroscopic data being accumulated by David Lambert and his collaborators at the University of Texas, should provide new information about the dynamical behavior of low-gravity, pulsationally-unstable atmospheres.

RV Tauri stars are defined as yellow pulsating supergiants showing alternating deep and shallow minima. In fact, there is a spectrum of behavior in different RV Tauri stars, ranging from strict alternating minima to almost random depths. About a third of RV Tauri stars show long-term variations in mean magnitude, and are designated as RVb stars. In the half-dozen well-studied RVb stars, the long period is about 15 times the shorter (pulsational) period. Figure 1 shows the long-term visual light curve of U Mon. The RVb variations have an unusually long period (2475 days) and a distinctly non-sinusoidal light curve reminiscent of that of an eclipsing binary. There are radial velocity variations of 30 km/s on the same time scale, but there appear to be no color variations accompanying the current RVb minimum, according to the results presented by Pollard et al. at this Colloquium. Note also that the amplitude of the RV Tauri variations appears to be smaller when the star is at long-term minimum. Figure 1 also demonstrates the AAVSO's newly-enhanced computer graphing capabilities.

Mira Variables. In a sample of 391 Mira variables, observed visually by the AAVSO for 75 years, about 15 showed long-term changes in mean magnitude (Percy

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et al. 1990). Almost all of these were S, N, C or R types, which suggests a relationship with the unique properties and/or evolution of these special types.

Small-Amplitude Red Variables are M giants pulsating with small amplitudes and periods of up to 200 days. A detailed study of one such star - EU Del - was published by Percy et al. (1989). We have now developed a simple autocorrelation method for analyzing the periodicity of large numbers of visual observations of these stars. Of the 10 stars studied, 8 show long-term variations on time scales of one to several years, an order of magnitude longer than the basic (pulsational) period, which is typically 20 to 100 days (Percy et al. 1992).

Supergiant Red Variables (SRc or Lc types) such as Betelgeuse show brightness variations on two time scales: a shorter one which is in approximate agreement with the fundamental radial period, and a second one which is about 10 times longer (Stothers and Leung 1971). In some cases, the long-term variations take the form of occasional large-amplitude cycles of the short-term variation (as in RS Cnc); in other cases, the long-term and short-term variations appear to be independent.

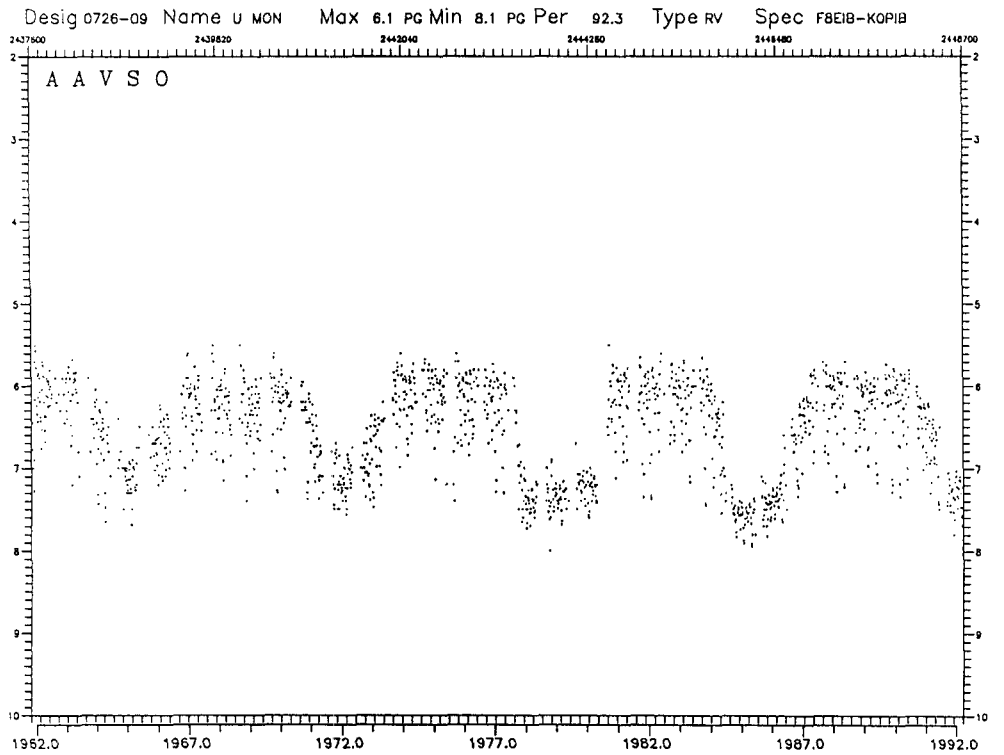

Figure 1 Five-day means of visual observations of U Mon, made by the AAVSO from 1967 to 1991. Note the 2475-day period, the unusual shape of the light curve, and the reduced

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scatter (pulsation amplitude) at long-term minimum.

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