WHAT DO WE KNOW ABOUT ALGOL?

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ABSTRACT

A comprehensive analysis of previously published observations of Algol has been submitted to Astronomy&Astrophysics under the title "Geometry and Dynamics of the Algol System". The main results can be summarized as follows:

The masses of the three components are m_A=3.6±0.1, m_B=0.79±0.01, m_C=1.6±0.1 solar masses.

The orbit of Algol C is co-planar with the AB-orbit within some 3°, but polarimetry of the eclipsing pair indicates that the senses of revolution are opposite.

The close orbit is circular, thus the 32 year period in the times of minima can <u>not</u> be explained by apsidal motion.

The photometric elements derived from a simultaneous analysis of 21 different light-curves show that the secondary fills its Roche lobe. The radii are R_A=2.89±0.04, R_B=3.53±0.04 solar radii, and the effective temperatures about T_A=12500 K, T_B=5000 K. Neither the gravity-darkening exponent for Algol B, nor the luminosity of Algol C can be determined from these analyses.

The photometric and spectroscopic observations of circumstellar matter can not be explained by a classical narrow stream between the components. Some magnetic interaction is probably involved, as can be inferred also from the radio synchrotron emission.

The alternate period-changes observed for nearly 200 years do not fit the standard Biermann-Hall model. At least 10^{-7} $m_{\odot}$ needs to be lost from the secondary each year. Part of it leaves the system, probably as a result of magnetic forces. A speculative proposal relates the 32 year periodicity in the times of minima to some stellar magnetic cycle.

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COMMENTS ON SÖDERHJELM

Guinan

The observed erratic period decreases observed for Algol could arise from systemic mass loss rather than mass exchange. The radio observations indicate that the system may be enveloped by tenuous gas. Perhaps mass loss from the system supplies this gas.

Söderhjelm

I agree.

Linnell

The speaker deserves commendation for presenting light curve solution data in the form of magnitude residuals. It is always pleasing to see a theoretical light curve that appears to pass through the observations, but a plot of residuals is the best way to assess the quality of the fit.

Bolton

Did I understand correctly that you are estimating a mass transfer rate of $4 \times 10^{-7} M_{\odot}/yr$? My Hα profiles suggest that the rate does not exceed a few times $10^{-9} M_{\odot}/yr$.

Söderhjelm

Yes, it seems very hard to get the large period changes without that much mass involved.

Hall

In response to Bolton's comment about your large value of $\dot{M}$, let me comment that similar values of $\dot{M}$ were derived from observed period changes in two dozen other Algols by me and S.G. Neff   (in Symposium No. 53). These rates, which correspond to the cooler star's thermal rate, are not steady-state values but rather averages over supposedly brief episodes of very high mass transfer. Let me also comment that a follow-up paper on the Biermann-Hall model (in Acta Astronomica 25, 1) emphasizes that the period changes require significant mass loss from the system as well as transfer.

Söderhjelm

I am aware of these works. Mainly, I disagree about the necessity for the mass-loss to come in large-scale bursts. I would rather have the path of a rather constant mass-flow modified by a variable magnetic field.

Brown

I would not want you to put binary polarimetry into disrepute by your statement that it gives the opposite sense of circulation of Algol to that from the other data. If you have taken the binary circulation to be the same as the circulation in the polarimetric Stokes parameters (Q, U) plane, then you may be incorrect. The (Q, U) plane circulation can be the same or opposite to the orbital circulation, depending on the quadrant of $\underline{i}$ ($0 - 90°$ or $90° - 180°$). Were you aware of that?

Söderhjelm

No, I was not. It would be very good if the methods did agree on the circulation.

Brown

It would be very disturbing if they did not!

Walter

Some months ago I also studied the problems of Algol. In my preceding report on the location of gas streams in Algol systems, I showed a diagram with spectroscopically derived values of the eccentricities, e, of the orbits and the positions of the periastrons, ω, for Algol systems with periods between 4 and 15 days, primary components of spectral types A and subgiant secondaries. It could be seen that the values of ω are situated in a distinct region, in this way making it very probable that the orbits are really circular and the eccentricities fictitious. Thus it seems to be very improbable that Algol has an elliptic orbit and that the thirty years period of the minima times may be explained by motion of periastron.

However, it offers another interpretation of this period. The large period of 600d in TV Cas could be explained by a precessional period of the rotational axis of the primary component, which is somewhat inclined to the orbital phase. Why should a similar effect not be working in the Algol system? I argue that the thirty years period is caused by precession of the rotational axis of the primary, and that the photometric effects occurring in connection with the gas stream distort the light curve. Especially in cases of partial eclipses it seems possible that minima times are derived which are systematically influenced. Moreover, the theoretical value of the precessional period of the Algol primary is in good agreement with the thirty years period.

Söderhjelm

The light-curve analysis shows that distortions large enough to influence the times of minima are unlikely.