THE PERIOD PROBLEM OF THE INTERACTING BINARY WHITE DWARF SYSTEM AM CVn

J.-E. Solheim
University of Tromsø
Institute of Mathematical and Physical Sciences
Tromsø, Norway

ABSTRACT

A short review is given of the searches for an orbital period of this (believed to be) interacting binary white dwarf system. Today, 3 or 4 periods are known. A polar ring accretion model is proposed to explain the observations - at least partly.

THE PHOTOMETRIC PERIOD

Periodic variability of this star was first detected by Smak (1967). He found a period of 17.5 minutes. The star was proclaimed to be the shortest period binary system then known. Many theories for the system were proposed, but rapid flickering in the light curve and no strong X-ray emission, eliminated all models except the interacting binary white dwarf system (Faulkner et al., 1972). In this model a low mass white dwarf orbits a normal mass white dwarf in a close orbit. Mass is transferred from the low mass star, which is peeled off matter layer by layer. Later, 3 other objects of the same type were discovered. AM CVn may still have the shortest orbital period of this group of stars.

Since only helium is detected in the optical spectrum, the mass losing star must be a helium white dwarf. An ultrashort period binary system will lose angular momentum by gravitational radiation. Detection of the secular changes in the period may therefore be a test of the theory of General Relativity or other theories of gravitation (Krisher, 1985). Assuming that gravitational radiation is the only way of removing angular momentum, GR predicts a rate of <u>increase</u> in the otbital period between 3.6 and 7.3×10^{-13}. Extensive observations by Patterson et al. (1979) showed an increase in the orbital period 1000 times this prediction.

The times of minima in the light curve arrive rather unprecisely. They can arrive up to 0.2 of the period too early or too late. Some-

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times one minimum is shallower than the other - or even missing for a few cycles. From one night to the next it is easy to commit a cycle count error, which may lead to calculation of a wrong period. Solheim et al. (1984) observed the system in 1982-83 and collected all times of minima published. It was shown that if one did not make a distinction between primary and secondary minima, and avoided cycle count errors, all observations could fit one period: 1051.04 s or exactly half of that. A secular decrease in the period was found to be 3.2×10^{-12}. This is a factor of 100 less than found by Patterson et al. (1979), but with an opposite sign with respect to the value predicted by General Relativity. This period was interpreted as a period of rotation, and it was shown that the spinning up of the accreator easily could be explained by the transfer of angular momentum in the accreation process. The orbital period became unknown.

At the same time, SFT analysis of long strings of old data (Kepler, 1984) showed periods of 1011.5, 525.6, and 350.4 s. No power was found at the period of 1051 s. This means that if the observing period is long enough there is no feature in the light curve that repeats with 1051 s period. The period can still be 1051 s, but only the higher harmonics are observed. The new period of 1011 s could then cause much of the changes observed in the light curve, making one minimum disappear, or arrive too late or too early, explaining some of the timing irregularities of the system. If the 1051 s (525.5 s) period is related to rotation, then the new period of 1011 s might be related to the orbital period.

No polarization is observed for the system, and if this is interpreted as a sign of a weak magnetic field, some of the phasing irregularities in the light curve can be explained if accretion happens mostly in the polar regions. Accretion may take place in a polar ring area and then mostly on the "night" side with respect to the donator. This produces the orbital modulation of the light curve. Part of the phase jitter may then be related to the migration in longitude of the accreting areas just as we observe it in the auroral regions on the Earth (figure 1). If the magnetic axes is tilted with respect to the orbital axes, we should also expect rotational modulation of the light curve.

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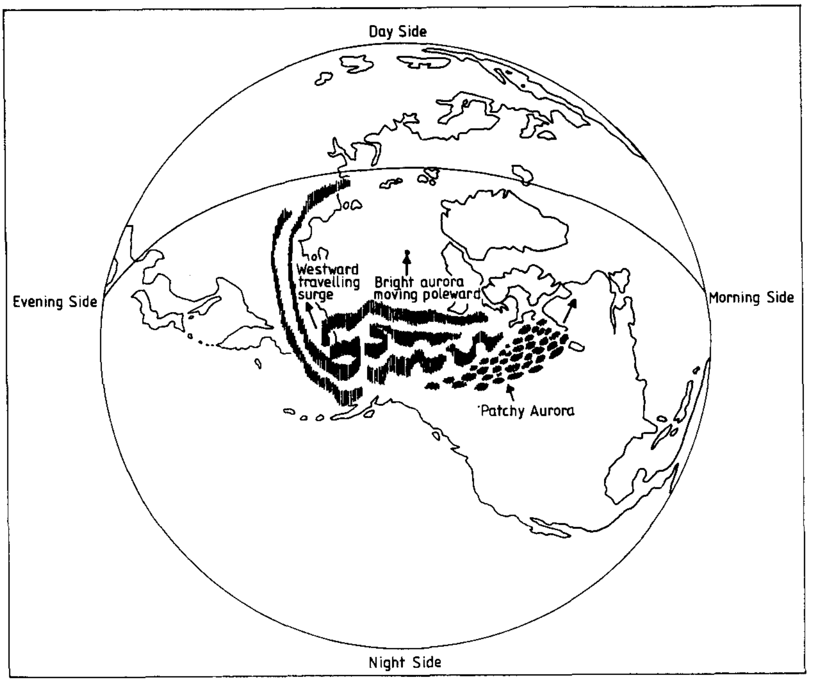

Figure 1: Basic auroral activities during an auroral substorm, when observed from above the north pole region.

SPECTROSCOPIC PERIODS

There has been 3 attempts to do high speed spectroscopy to determine the orbital velocity. Robinson and Faulkner (1975) did not find any secular variations or variations over the 17.5 min photometric period. They claimed to be able to detect sinusoidal variations with a semi-amplitude greater than 30 km s^{-1}. Voikhanskaya (1982) observed with the 6 m telescope, but did not succeed in detecting the 17.5 min period. Attempts made at La Palma in 1987 by Lazaro et al. (1988) will be reported at this meeting.

Observations of IUE spectra (Solheim and Kjeldseth-Moe, 1987) showed narrow absorption lines of C, N and Si which vary in intensity with time, always blueshifted. This is interpreted as a sign of an optically thick wind seen against a bright disk. There are only marginal signs of a P-Cygni profile now and then, and from line profile studies, it was concluded that the orbital inclination is less than 30 degrees.

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This may explain the difficulty in making spectroscopical velocity studies.

FUTURE WORK

It is proposed to include this system in the whole Earth Telescope Project (Nather, 1988) to do as continuous observations as possible. This may solve the problem of the interpretation of the multiple periods observed, and also indicate if any of them are related to g- or r-mode pulsations, which also may be present in such a disturbed system as we believe AM CVn is.

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