20.08

Light Curve Analyses of the Eclipsing Binaries in the Globular Cluster NGC 5466

E.F. Milone, C.R. Stagg (RAO), J. Kalirath (U. Bonn and BASF)

The CCD V and B passband light curves of three short-period eclipsing variables published by Mateo et al. (AJ 100, 469, 1990) have been analyzed with the Calgary version of the Wilson-Devinney synthetic light curve program further enhanced by the addition of a spot modeling simplex code by JK. The latter improvement permits exploration of the uniqueness of the solutions. The results confirm the natures of the short-period Algol system (NH31) and of the contact systems NH19 and NH30. Both DC and simplex investigations indicate a slight preference for a detached, transit solution over either semi-detached or detached occultation solutions in NH31. Both NH19 and NH31 are shown to be over-contact A-type W UMa systems, very close to their outer lobes. The existence of these short-period systems in such an ancient cluster (18 Gy -according to Nemec and Harris, ApJ 316, 172, 1987) offers strong support to the late evolution of such close binaries, particularly to the merger scenario by angular momentum loss.

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20.09

Variations in the Gas Stream, Disk, and Photosphere in AU Micronovorctis Throughout Its Long-Term Light Cycle

G. J. Peters (USC)

AU Mon (B3V + F5G, P=115.11 s) is an interacting binary of the Algol type that displays an interesting periodic long-term (411°) variation of 0.0525 in its optical light (Lorenzi, IBVS N°2704, 1985). Paired sets of IUE observations at orbital phases, φ = 0.85 (looking through gas stream) and 0.25 (quiet phase) have been acquired at several phases points in the long-term cycle to investigate the role of the optical light variability and look for variations in the circumstellar material. Selected results from this study are reported here. Analysis of the continuous flux distribution from low dispersion IUE data reveals that the cause for the optical light fluctuations is a cyclic variation of ~1200 K in the primary's photospheric temperature and the addition of a blue-ward (~10,000 K) continuous source (probably from an optically thick accretion disk) at maximum light. IUE observations have confirmed that the mass transfer rate and disk absorption are largest when the star is faint (φ < 0.5). There appears to be a phase lag in the response of the accretion disk to changes in the mass transfer rate. Line absorption from the disk reaches a maximum at φ = 0.5 but remains large through φ = 0.9 (bright). IUE data acquired since mid-1988 reveal that the mass transfer rate abruptly declines at φ = 0.75, midway between minimum and maximum light. In fact from 0.75 < φ < 0.00 any line absorption from the gas stream is overwhelmed by that from the disk and these observations give an upper limit for M that is less than 0.1 the value observed near φ = 0.5. Collectively the data suggest that the flux variation in AU Mon results from a periodic fluctuation in the mass transfer rate and may be caused from an oscillation of the secondary star about its Roche surface. This varying mass transfer activity in turn causes the accretion disk to undergo a periodic variation in density and perhaps overall dimension. Support of this project from NASA Grant NAG-5922 is gratefully acknowledged.

Session 21: Cool Stars

Oral Session, 2:00-3:30 pm
Cascade I

21.01

Spherically Symmetric Model Atmospheres of Late-Type Stars

P.D. Bennett (UBC)

A computer code has been developed to model the extended atmospheres of late-type giant and supergiant stars. The atmospheres are assumed to be static, spherically symmetric and in radiative and hydrostatic equilibrium. Molecular line blanketing (for now) is handled using the simplifying assumption of mean opacities. The complete linearization method, adapted to spherical geometry, is used to solve the model system. The radiative transfer is solved by using variable Eddington factors to close the system of moment transfer equations, and the entire system of transfer equations plus constraints solved efficiently by rearrangement into the Rybicki block matrix form. The variable Eddington factors are calculated from the full angle-dependent formal solution of the radiative transfer problem using the impact parameter method of Hummer, Kusn and Kusn. A novel method of linearizing the radius coordinate which allows the use an optical depth scale was developed. The resulting formulation is analogous to the plane-parallel complete linearization method and reduces to this method in the compact atmosphere limit.

Models of M giants were calculated for T eff =3000K and 3500K with opacities of the CN, TiO and H2O molecules included, and the results presented. These models were calculated assuming radiative equilibrium. The importance of convective energy transport was estimated by calculating the convective flux that would result from the temperature structure of the models. The standard local mixing length theory was used for this purpose. Convection was found to be significant only at depths with Td > 10. Thus, the temperature structure of the surface layers and the emergent flux should be accurately described by the current radiative models.

21.02

Numerical Simulations of Flares on M Dwarf Stars

Chung-Chieh Cheng (NRL), R. Pallavicini (Arcetri Obs.)

We have made a series of numerical simulations of flare loop models with different values of loop size, flare energy input, and initial loop conditions in order to understand the large variety of physical parameters observed in stellar X-ray flares on M stars. Our model solves the full set of mass, energy, and momentum equations in a magnetically confined loop structure which extends from the chromosphere to the corona. We have coupled the hydrodynamic results with an X-ray spectroscopy code to calculate the observed X-ray emission and compared it with X-ray light curves obtained by the EXOSAT satellite. Our simulations can reproduce the general characteristics of the observed X-ray flares, including their intensities, time profiles, and average coronal temperatures. We find that it is possible to produce X-ray emission measures of up to 10^53 cm^-3 with fairly small loops with a total length of only 2 x 10^5 cm, in contrast to previous conclusions that required large loops, of the size of a stellar radius, even for small flares. We find, however, that the amount of material that can be evaporated from the chromosphere does not vary linearly with the flare energy input, thus making it increasingly more difficult to obtain large emission measures by simply increasing the energy input in a small loop. Under physically realistic conditions, large loops with length of ~8 x 10^5 cm are required to produce the largest emission measures (~10^53 cm^-3) observed in stellar flares. The large evaporation velocities of more than 400 km s^-1 predicted by our models should be observable as blue shifts in X-ray line profiles with the high resolution spectrometers planned for future missions such as AXAF.