THE HIGHLY ECCENTRIC, INTERACTING BINARY A0538-66

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The unusual nature of the recurrent X-ray transient A0538-66 became apparent when its location in the LMC indicated an X-ray luminosity at peak of $\sim 10^{39}$ erg s^{-1}, $\sim$10 times brighter than any other galactic X-ray source and comparable to the integrated X-ray output of a normal galaxy. The X-ray outbursts recur every 16.65 days at which time the optical counterpart brightens from B $\sim$15 to 13. Archival plates show that this has occurred for at least the past 50 years, although there are times of inactivity when no outbursts occur (Skinner, 1981, Sp.Sci.Rev. 30, 441). A0538-66 was inactive for most of 1980 but CTIO 4 m and AAT spectroscopy in Dec/Jan 1980/81 indicated growing activity (Balmer, He I emission) superposed on the spectrum of a B2 III star (Charles et al, 1982, MNRAS 201, in press). At maximum the spectrum lines show complex P Cygni profiles and powerful He II 4686 emission (presumably indicating the turn-on of the X-rays). An IUE spectrum near minimum light showed the continuum of a B2 III star (T_{eff} = 18500 K) together with a C IV λ1550 P Cyg profile giving a wind velocity of v_∞ = 1600 km s^{-1}. IUE spectra near phase 0 indicated that C IV, He II, N V and Si IV were now very powerful and broad ($\sim$3000 km s^{-1}, in stark contrast to the UV spectra of other galactic X-ray sources) superposed on a redder continuum of a $\sim$B 9 I star (T_{eff} = 12000K).

The periodic nature of the outbursts clearly require an eccentric orbit. Taking a 12 $M_\odot$ B star and a 1 $M_\odot$ neutron star indicates a maximum e$\sim$0.8 if the compact object skims the primary's surface. The source of the mass transfer is unlikely to be a stellar wind and we thus interpret the mass transfer as tidal lobe over-flow. Since the primary is rotating at 400 km s^{-1} (the quiescent spectral lines are resolved) then "co-rotation at periastron" is achieved and the (modified) Roche lobe formulae give e = 0.7 assuming that the primary fills its Roche lobe at periastron. About 10^{-7} $M_\odot$ material is available for transfer when this lobe lies within the B star envelope. Hence the observed L_x can be obtained with an efficiency of only $\sim 10^{-3}$ (since radiation pressure effects will be substantial). A large amount of this material forms the large optically emitting region at outburst. The recent discovery of 69 ms X-ray pulsations by Skinner et al (1982, Nature 297, 568) supports this model because the observed $\dot{P}/P$ implies e = 0.7. This extraordinary object may thus periodically approach the condition of a common-envelope binary.

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