WHAT CAN WE LEARN ABOUT CONTACT BINARIES WITH THE HELP OF FAR UV AND X-RAY OBSERVATIONS?

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The IUE and Einstein satellites have changed the clean and simple contact binary (W UMa-type) surface to a more "dirty" one where spots, flux tubes, coronal loops, flares etc. disturb the stellar image. The situation is, of course, the same for many other active stars as well. Here we discuss some aspects of this increased activity which may be relevant for the contact binary evolutionary theory.

1. The changing slopes in the overall coronal X-ray emission with decreasing period (see the Figure) are probably due to combined dynamo and tidal effects. The tidal effects may e.g. reduce the differential rotation or open the magnetic field lines, which diminish the dynamo-action and closed loop-structures. The obvious break between detached and contact binaries perhaps reflects the luminosity transfer process from the primary to the secondary, the knowledge of which is of crucial importance for any structure theory of W UMa-stars.

The saturation of the transition region (NV+SiIV+CIV) resonance lines (see the Figure, weak dependence on period and spectral type below $P \sim 3$ days for both detached and contact binaries) is perhaps due to the saturation of coronal loop pressures and filling factors, but the loops become smaller and cooler when physical contact sets in.

In the far future we may hope to combine these far ultraviolet and X-ray observations with a satisfactory magnetic braking theory to compute the angular momentum loss, which obviously is a very important factor for the correct evolutionary theory.

2. The presence of spots on more massive components seems to be a reasonable explanation of the W-subtype syndrome (the secondary is slightly hotter). "Is the primary more active also in the far ultraviolet and X-rays?" is a question which needs further study. The behaviour of MgII 2800 in W UMa and CIV 1549 in 44 ιBoo is not at least in contradiction with this picture, but the phase-dependence in X-ray emission of VW Cep may not be so simple. The neck and mass flows may also give important contributions.

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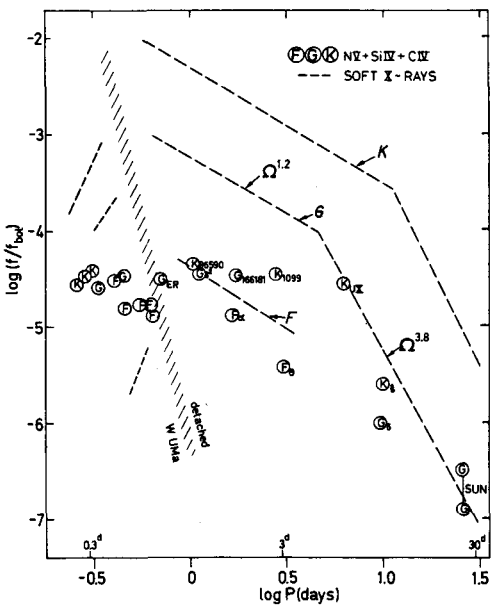
Preference of activity for more massive components can be plausible accommodated in all presently considered theories of contact binaries: in the thermal-relaxation-oscillation (TRO) and angular-momentum-loss (AML) theories it would be due to the much thinner convective zone of the secondary (weaker dynamo); in the contact-discontinuity (DSC) theory it would be due to difficulties in magnetic field penetration through the discontinuity.

3. The ultraviolet excess δ(u-b) indicates elevated fluxes in the u-band (Balmer-continuum emission) in late spectral type systems (later than G8) or in systems near the short period boundary of the period-colour diagram (i.e. shortest period for a given b-y). One example is V566 Oph which is near the short period boundary as compared with ϵCrA which has the same colour but longer period. V566 Oph is also much more active in the X-rays.

In model computations the homogeneous ZAMS-systems (unevolved primary) are situated closest to this short-period boundary. In the TRO- and AML-theories these are also the systems which most deviate from thermal equilibrium (having hence more violent cycles or angular-momentum-loss, respectively). In the DSC-theory they apparently need larger discontinuities. In this way the stars near the short period boundary can be expected to be most unstable, and hence perhaps most active. Note, however, that the general trend across the period-colour diagram (for a fixed colour) may be the opposite (see the Figure). Perhaps a sharp rise of activity takes place only rather close to this boundary, as δ(u-b) and V566 Oph vs. ϵCrA suggest. Clearly more observations of the high δ(u-b) stars near the short-period boundary are desirable.



The above considerations are based on the following papers where also all the relevant references can be found:

Rahunen,T. and Vilhu,O. (1982), Origin and Evolution of Contact Binaries of W UMa Type, IAU Coll. 69, p. 289.

Rucinski,S.M. and Vilhu,O. (1982), IUE Observations of W UMa-type Stars, MNRAS (in press).

Rucinski,S.M., Vilhu,O. and Kaluzny,J. (1982), Activity of Contact Binaries, IAU Coll. No. 71.

Vilhu,O. and Rucinski,S.M. (1982), Period-Activity Connections in Close Binaries, Astron. Astrophys. (submitted).