# SUMMARY AND CRITIQUE OF JOINT DISCUSSION II

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ABSTRACT. Notes made during the presentations of Joint Discussion II have been distilled into the interpretation of this summary.

It is difficult to assign a beginning to the topic of this Joint Discussion. Is it reasonable to say that the subject matter began with Ludendorff's (1912) discussion of the 19th century observations of Eps Aur and their compilation into an "Algol-like" light curve? Or should Vogel (1903) be given priority on the basis of his conclusion that Eps Aur is a long period spectroscopic binary? Or do we pass much further back to the notice by Fritsch (1824) of a minimum of Eps Aur in 1821? (Presumably the 1709 faint observation of Zet Aur, or the possibly bright observation of Eps Aur, by G. Kirch (Argelander 1869) has nothing to do with the eclipse of either object since the present ephemerides for the two systems predict no minimum near that time.) Have many not forgotten that Gaposchkin (1935) offered the first insights into the then unfamiliar nature of the atmospheric eclipse intervals of Zet Aur?

This rhetoric is intended only to demonstrate that the lineage of the Joint Discussion is a very long one and that many astronomers have contributed to it. I now concentrate on the substance of the invited and contributed papers in the Discussion itself. It is not out of place, I think, to make still one more plea for clarity, if not uniqueness, of terminology: the adjectives primary and secondary applied to binary members can commonly mean different things to a speaker and to his audience. They might better be forgotten and replaced by the appropriate combination of massive, less massive, brighter, fainter, larger, and smaller if these characterizations are known. It is also not to be forgotten that it is in the nature of cool supergiant stars that their brightnesses are very wavelength dependent and, to some degree, so are their radii as these radii are operationally evaluated by different observational techniques.

Some comment on observational practices is appropriate. It is



*J.-P. Swings (ed.), Highlights of Astronomy, 197–200.*

particularly heartening to have heard of applications of the VLA, IUE, and Einstein yielding new ways of learning of the behavior of upper levels of the static and expanding envelopes of the supergiants. As we all know, however, stellar science is not a domain in which all problems succumb to new discoveries outside the visible band; what these novelties show us are new insights and new recognitions of ignorance. Modernized applications of familiar visible band procedures are beautifully evident in, for instance, the Texas instrumentation. And there will continue to be a place indefinitely for the very well-understood methodologies pursued in Italy and Japan and described in papers regarding Eps Aur. Lastly, there must be warm appreciation of those dedicated amateurs who are now furnished with photoelectric instrumentation and who worked so effectively to delineate the eclipse curve of Eps Aur.

It was inevitable that a large fraction of the Discussion be given over to Eps Aur. The recent eclipse is the best observed and the character of the eclipse can no longer be a matter of debate unless there really are going to be long-term consequences of a collapse of the F-star envelope. It is clear that there is much new insight, in both thermal and dynamical senses, into the behavior of the cool source. Some emphasis was given to disagreements arising from the small number of Eps Aur models which differ in the structure and behavior of the cool source. This is only to be expected since modern results showing the fine structure of the light curve cover only two eclipses.

From the point of view of observational evidence, most of the remaining papers dwelt upon details - some of them quite extraordinary - for specific systems. The interpretation presented for HM Sge, which may or may not eclipse and for which a period is not even known, was particularly interesting. It was also a welcome matter to see that there are now known systems of about 100-day period with member stars straddling a large fraction of the abscissa scale of the HR Diagram. These few objects are perhaps the ones which we should expect to discover in order to pass fainter in the Diagram toward the ensemble of related pairs - symbiotics, Serpentids, Bet Lyr-type objects, etc. - which were the subject of the fifth invited review. Only one paper concerned itself with the further evolution of advanced binaries and this one appealed to a very wide ZAMS progenitor passing through the "common envelope" evolutionary stage. Much more theoretical study remains to be done.

It is possible to try to make a further synthesis of the systems which were presented at the Discussion and of some others which are known or believed to be analogues of them but which made no appearance during the presentations. This is done without regard to questions of the nature of the eclipse phenomena or of whether the systems eclipse at all. In Table I Categories are defined by specific example, but as always, stellar studies resist rigid compartmentalization.

Table I. Categories of Long Period Binary Systems

| Category | Examples | Remarks |
|---|---|---|
| 1 | 22 Vul, HM Sge, RR Tel:, V1067 Cyg: | One compact member |
| 2 | Eps Aur | One IR source |
| 3 | VV Cep, Cowley (1969) stars, Del Sge | M- or near M-supergiant or bright giant with near-ZAMS hot companion |
| 4 | Zet Aur, 31 Cyg, 32 Cyg, V381 Sco, V383 Sco, | K- or near K-supergiant or bright giant with near-ZAMS hot companion |
| 5 | PW Pup, HD104901B, 5 Cet:, W Cru: | Fainter and cooler cool star than in Category 4 |
| 6 | "Related"systems | Still fainter systems with vigorous mass flow |

Despite their imperfections, these Categories will be used to indicate (a) information (!) that was presented at the Discussion although perhaps not for the first time, (b) information (#) already known but not described in Delhi, and (c) knowledge (?) that as yet we do not know.

Table II. Relative Levels of Information for Long Period Binaries

| Information/Category | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Scaled orbit(s) | # | ! | # | # | ? | # |
| Unscaled star (disk) dimensions | # | ! | ! | # | ? | # |
| Star (disk) absolute dimensions | # | ! | ! | # | ? | # |
| Spin velocities | ? | ! | # | # | ? | # |
| Photospheric activity | ? | ! | # | # | ? | # |
| Chromospheric activity | # | ! | # | # | ? | # |
| Coronal (wind) activity | ! | ? | # | ! | ? | # |
| Magnetosphere(s) | ? | ? | # | ? | ? | # |
| Chemical composition | ? | ! | ? | # | ? | # |
| Evolutionary stage | ! | ! | ? | # | ! | # |

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but the notation means only that the Discussion developed some information regarding that item for a least one member of the Category. The number of these entries is considerable indicating very substantial content to the Discussion. This should not be construed to mean that the level of knowledge is satisfactory. A similar qualification must attend all the "#" entries; what we knew before (and did not hear repeated at the Discussion) is too often rudimentary information for some example(s) of these Categories. But what we know we don't know represents opportunity for us and for our colleagues and students.

It is hoped that the platitudinous nature of part of this review will be forgiven. Several people will not fail to note some resemblance between the oral presentation in Delhi and this written account.

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