SESSION III

INTERPRETATION

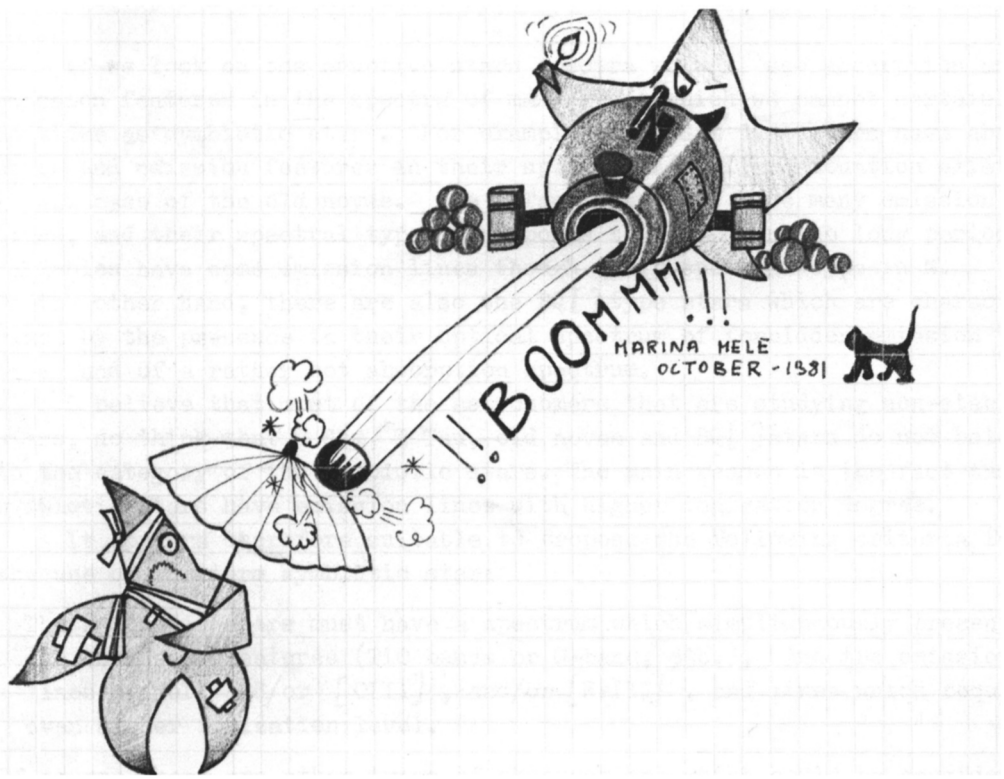
Chairman: H. Nussbaumer

Introductory reports on:

THE TERM SYMBIOTIC STAR (A.A. Boyarchuk)

BINARITY (M. Plavec)

MODELS (M. Friedjung)



Symbiotic Stars: Outburst of one Component.

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DETERMINATION OF THE TERM SYMBIOTIC STAR

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Symbiotic stars have been studied for many years. But the common determination of the term "symbiotic star" does not exist even now. Merrill (1958) introduced this term in order to emphasize unusual spectral features - absorption TiO bands and emission lines belonging to highly ionized ions.

If we look on the eruptive stars spectra we well see absorption and emission features in the spectra of many stars which we cannot certainly consider as symbiotic stars. For example the U Gem type stars have absorption and emission features in their spectra. A similar situation exists in the case of the old novae. The T Tau type stars have many emission lines, and their spectral type corresponds to G-K. Even the long period variables have some emission lines though their spectral type is M. On the other hand, there are also the BQ[ ] type stars which are characterized by the presence in their optical spectrum of forbidden emission lines and of a rather hot absorption spectrum.

I believe that most of the astronomers that are studying non-stable stars, do think that U Gem, T Tau, old novae and BQ[ ]stars do not belong to the category of the symbiotic stars. The main reason is the fact that symbiotic stars have emission lines with higher ionization degree.

It appears therefore suitable to propose the following criteria for the use of the term symbiotic star:

> The symbiotic stars must have a spectrum which simultaneously present the cool star features (TiO bands or G-band, etc.), and the emission lines of HeII and/or [OIII] , and/or [NeIII] , and lines which require even higher ionization level.

Of course there are other types of observations which could be considered, but they can be used to divide symbiotic stars into different subclasses. As a first approximation, it can be proposed the following classification of symbiotic stars according to different types of observations:

M. Friedjung and R. Viotti (eds.), The Nature of Symbiotic Stars, 225–230.

1. According to UBV photometry:

Z-stars, with light curves as Z And
A-stars, with light curves as AG Peg
R-stars, with light curves as R Aqr

2. According to the infrared observations:

S-star, whose infrared spectrum corresponds to that of a cool star
D-star, whose infrared spectrum corresponds to that of dust emission
N-star, with constant infrared radiation ($\Delta K \lesssim 0^m.1$)
V-star, with variable infrared radiation ($\Delta K \gtrsim 0^m.1$)

3. According to the radio observations:

E-star, having a detectable radio emission ($\sim>$ 10 mJy)
Q-star, with no radio emission ($\sim<$ 10 mJy)

4. According to the absorption spectrum:

M-star, with M-type absorption spectrum
Y-star (yellow), with F,G, K-type absorption spectrum

5. According to the emission spectrum:

a) the degree of excitation which is indicated by the average ionization potential of the emission lines (Allen 1979)
b) relative intensity of the recombination and forbidden lines which is an indication of the electron density. Allen (1979) has proposed four classes: l - low, m - middle, h - high, and e -extremely high electron density.

The amount of the ultraviolet and X-ray observations is not enough at present to permit any classification.

I think that the above groups of symbiotic stars are not independent. For example D-type stars (having dust) show infrared variations (V-type). They are also radio sources (E-type) and usually have lower electron density (l-type). I think that the future investigation will permit to establish a small number of independent classes of symbiotic stars.

REFERENCES

Allen , D.A.: 1979, Proc. IAU Coll. No.46 "Changing Trends in Variable star Research", F.M. Bateson, J. Smak, I.H. Urch (eds), of Waikato, Hamilton, p.125.
Merrill, P.W.: 1958, "Etoiles à Raies d'Emission", 8th Coll.Liège,p.436.

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DISCUSSION ON THE TERM SYMBIOTIC STAR

Whitelock: When we are trying to ascertain the presence of a cool star, then we should not restrict ourselves to the photographic region. The presence of H_2O or CO in the infrared spectrum is just as good an indication of the presence of a cool star as is TiO or the G Band.

Slovak: We need a luminosity class criterion in addition to a spectral class criterion, since most late type components in symbiotics are believed to be giants, as opposed to dwarfs or supergiants.

Boyarchuk: The determination of the luminosity class is not so simple a problem in the case of the symbiotic stars. The main reason is that those stars are faint and their spectrograms have low dispersion. Moreover, the presence of both line and continuous emission gives additional difficulties. As a result only a few symbiotic stars were classified according the luminosity.

Friedjung: The recurrent nova T Coronae Borealis would fit these criteria. The cool component is even a giant. The trouble is that we do not know enough the physics. Ground based spectra also cover too narrow a range.

Huang: Are there any dwarf symbiotic stars?Now we have got giant and supergiant symbiotic stars, being in my opinion AG Dra a supergiant star.

Viotti: I want to recall the fact that AG Dra recently underwent a nova-like outburst after a long period of relative quiescence. Its historical light curve resmbles that of Z And, although the stars are different in many aspects.

Hack: I think we should speak of the symbiotic phenomenon rather than of symbiotic stars (e.g. AG Dra at some epochs was more similar to Z And, and at others to VV Cep). We should base our classification also on the properties of the outbursts like the number of shells observed, the expansion velocity, the mass loss per outburst, the energy emitted during an outburst, the ratio between the energy emitted during an outburst and that emitted between two successive outbursts, the average time interval between outbursts, and the average duration of an outburst.

Slovak: We need to restrict the symbiotic definition, at least spectroscopically, to quiescent phases, since the spectral features change remarkably during and following outbursts.

Kafatos: Should we add the term variability to the definition? If so, it seems to me that symbiotics are characterized by timescales of years or so rather than the much shorter ones which characterize other types of stars, like dwarf novae, etc.

Slovak: The only thing we can say is that variability over timescales of minutes does not exist.

Kafatos: At least in the IUE range we can exclude timescales of hours. We have made a point to observe various symbiotics at the beginning and end of one or two shifts (8-16 hours) and we find no variations over these timescales.

Whitelock: When discussing infrared variability we shoyld refer to large amplitude variation. Our infrared observations indicated that those objects that are often called 'non variable' - the S type symbiotic stars are variable with a low amplitude, sometimes periodically.
In reply to the question: 'is this fundamental, or a matter of degree', I would say that it is fundamental in the sense that the large amplitude variables are Miras, while the others are not Miras.

McCarthy: Regarding the variability of Red Stars, I agree with Dr. Whitelock that it is important to distinguish in the infrared between large amplitude (Mira variability) stars and non large amplitude stars. I know no M type giant where stability greater than 0.1 mag has been established. I add that spectral types seem to show much more constancy.

Michalitsianos: Symbiotics in the ultraviolet present a spectrum very similar to planetary nebulae. The only thing that tells a UV observer that he is in fact looking at a symbiotic star is that someone has found evidence for a cool component in the optical or infrared.

Whitelock: In the infrared the reverse is often the true: they are not different from M giants.

Fehrenbach: The two features: TiO and G band, and the emission lines of NeIII etc. appear during time variations, and do not need to be simultaneous.

Kwok: How many of Allen's 112 objects satisfy our criteria? As I recall, the only criterion he used was an emission line object with some emission.

McCarthy: Here we are at an important stage in our study of these fascinating Symbiotic Stars. Let us try not to be overrestrictive now in assigning "defining" criteria. I agree with Boyarchuk's basic definition - which elaborates correctly Merrill's definition and does not impose excessive limitations on the kinds of objects we may study.
In future years wide angle H_α emission surveys will give us more and more objects for study, including Be stars, SS433 objects, T Tauri stars, carbon + M emission stars, Planetary Nebulae, Emission Line Galaxies and Symbiotic Stars. These surveys will reach fainter and fainter limits of apparent red magnitudes. We should not now overclassify these symbiotic objects. I suggest we look back to our predecessors in spectral classification about 100 years ago. Let some of us work as Huggins did in England on a very restricted number of stars whose spectra he studied in great detail; let others of us work as Secchi did discovering numerous emission objects and separating them out on a broader scale and in less detail.
So as we come towards the conclusion of this most interesting and productive conference, we realize more than we did before that we are only at the beginning.

Nussbaumer: We have tried to define what makes a symbiotic star. From the desperate remarks (which alas will not enter the published version) that emerge it is obvious that these discussions will not result in anything like a final definition of symbiotic stars. Could we try to arrive somewhere by way of elimination. Is there some strong feeling among the partecipants that some objects which have been called symbiotic stars should refuse that name?

Michalitsianos: We want to have a formal definition of a symbiotic star because many observers place peculiar emission stars in such a category when they know of no other category. As such, symbiotics have tended to be a collection of odd objects that clearly do not belong to any other astronomical category, somewhat like a rubbish bin!

Houziaux: From the discussion, it appears that a star at a symbiotic phase is a composite object with cyclic variations whose line spectrum looks like that of a planetary nebula in the ultraviolet, and like a K or M giant star in the infrared.

Viotti: I think that the present discussion has a broader astrophysical interest than it would appear from the small number of stars called "symbiotics" here discussed.
Clearly, classification - in Astronomy, or in Biology or else - is a question of methodology: one collects a number of astronomical events and puts them in a few boxes - the O, B, A... stars, novae, T Tauri

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stars, etc. - to make some kind of "order" in the multiform astronomical phenomenology. The common error is to assume that stars in the same box have the same physical properties and should belong to the same evolutionary stage. This is certainly not the case of the symbiotic stars which may well represent a collection of objects of different nature.
It is true, on the other hand, that the symbiotic phenomenon is not peculiar to only these stars. It is related to other physical processes, like mass loss/transfer/accretion, stellar coronae etc., that are presently of large astrophysical interest, and that probably are particularly effective in the stars discussed here.
Hence their detailed study may give the key to better understand these processes, rather than to define a new class of stars.

Friedjung: I would like to make a historical note. I proposed one should have a meeting on symbiotic stars 2 years ago in Montreal. However Roberto did not believe symbiotic stars existed and I was at first discouraged. He changed his mind some months later, and then we started to organize this meeting.

Nussbaumer: Perhaps we might after all still add the property which I suggested half jokingly:
It cannot be classified as something else.

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