COMPARISON OF PLANETARY NEBULAE AND SYMBIOTIC STAR EMITTING REGIONS

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The spectra of symbiotic stars generally display many emission lines seen in moderate to high-excitation planetary nebulae, but are superposed upon a strong continuum characteristic of a cool star, typically of type M. Furthermore, the spatial distribution of symbiotics has been noted to resemble that of planetaries. These similarities suggest that the symbiotic stars and planetary nebulae might have some relationship (causal or otherwise) or that they might arise from similar progenitors.

We have secured and analyzed contemporaneous spectrophotometric IUE images and ground-based scans which cover the entire range, λλ 1200-8000 Å, of several "S-type" (stellar) symbiotic stars, notably AG Peg, RW Hya, AG Dra, YY Her, and V443 Her.

All of the stars studied clearly appear to be binaries. The hot components are all well below the main sequence, but, with the possible exception of AG Dra, are not degenerate stars. Hot component He II Zanstra temperatures are in the range 85 000 - 115 000 K. The cool components are M stars, probably of luminosity class II-III.

Emitting line region electron temperatures are typically 9000 - 15 000 K, and perhaps as high as 20 000 K for YY Her. The electron densities in our sample are in the range 1-50 x 10^9 cm^{-3}. Though the electron temperatures are similar to those of planetary nebulae, the electron densities definitely are not. These results are similar to those found for a few other symbiotics (Altamore et al., 1981, Astrophys. J., 245, 630; Michalitsianos et al., 1980, Nature, 284, 148). As in planetary nebulae, photoionization appears to be the dominant energy-input mechanism, except possibly in the case of AG Dra, which is a soft X-ray source. There is often considerable and variable bound-free and free-free H emission producing a strong contribution to the total energy distribution.

One object, AG Peg, is clearly an evolved system near the second stage of mass transfer, but, significantly, probably has not undergone a planetary shell-ejection episode. The cool component currently is not filling its critical Roche surface. The hot component of YY Her appears to be embedded in a large disk-like structure, and we probably view this system from near the orbital plane.

The observational morphology, eruptive behavior, and our diagnostic results suggest that some S-type symbiotic stars consist of a hot subdwarf embedded in a dense, but small, nebula or "disk-like" structure

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which presumably must be supported by either cool component mass loss or hot component stellar wind. The symbiotics may be from a stellar population similar to that of planetary nebula progenitors, but no direct evidence exists that S-type symbiotics are the result of planetary nebular eruptions in binary systems.

WADE: In the stars that you have observed, is the Balmer decrement consistent with case B?

KEYES: The Balmer decrement in these stars is similar to that in case B, but it should be realized that there is a strong, narrow "nebular" component and a very broad component to the Balmer lines. Undoubtedly, different physical conditions pertain to the various emitting regions. We are not able to separate the components in our current spectrophotometric observations.

NUSSBAUMER: I should like to emphasize that symbiotic stars are not a homogeneous class. Some may be binaries, others are probably single stars. Some may be related to the nova phenomenon, whereas others may well be PN in a very early stage of evolution; V1016 Cyg is probably the best studied representative of the latter group (e.g. Nussbaumer and Schild, 1981, Astron. Astrophys. 101, 118). These symbiotics may be an important part of the missing link between Red Giants and more evolved PN.

KEYES: I agree that the "D-type" symbiotics, such as V1016 Cyg, seem to be slightly more akin to PN than the "S-type" symbiotics studied here.