The Infrared HR Diagram - The IRAS Two-Colour Diagram of AGB Stars and Its Evolutionary Explanation

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In recent years several people have used the IRAS data to produce ([25] - [60]) / ([12] - [25]) two-colour diagrams of late type stars (Van der Veen and Habing 1988; Qing-Quan 1988). The distribution of all these AGB stars are concentrated in a limited area, and any special series of stars are limited on a definite curve which can be represented by an exponential equation like

$$[25] - [60] = A + B \exp([12] - [25]).$$

Here [X] = -2.5 log flux and A, B, C are constant coefficients. On the other hand, we can make a model calculation to fit all these distributions. There are two kinds of models. One is a temporal model for different kinds of objects; another is an evolutionary model for stars with different initial mass. All these models are determined by the initial depth of the dust-gas envelope, the emission and absorption coefficients of the particles within the envelope, etc. So by comparing the real two-colour diagrams with these theoretical models we can determine many basic properties of late-type stars, especially those of AGB stars. Our results follow. (1) The initial masses of AGB stars are between 1 to 8 solar mass. (2) The mass loss rate of AGB stars varies from 10^{-7} to 10^{-5} solar mass per year. (3) The temperature of the photosphere of AGB stars are between 2000 to 3000 K. (4) The optical depths at the 12 micron band are between 10^{-3} and 10^{-2}.

Finally, the evolutionary scenario for AGB stars are as follows. At first the mass loss rates are still very low so the IR excess are small; at a certain moment in the AGB life the mass-loss rate increases steeply so that the IR excess increases and the position on the two-colour diagram moves from lower left to the upper right. At the same time the 9.7 and/or 11.3 micron feature changes from strong emission to strong absorption gradually, and the star changes from a mira variable to an OH/IR source.

References

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