HIGH MASS STAR FORMATION ALONG THE HUBBLE SEQUENCE

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ABSTRACT. The relationship between the far infrared and Hα luminosity has been investigated for a sample of 124 spiral galaxies. We find that the observed far infrared luminosities are comparable to the luminosities expected from the high mass O and B stars which are required to ionize the hydrogen gas. Consequently the far infrared luminosity appears to be a measure of the high mass star formation rate in spiral galaxies. In addition, the all sky IRAS survey has been used to quantify the birthrate of high mass stars for a complete volume limited sample of ~ 1000 spiral galaxies selected from the *Nearby Galaxies Catalog*. Our analysis indicates that the median high mass star formation rate is independent of morphology for spirals of types Sa - Scd inclusive. As such, our results challenge the growing perception that the median high mass star formation rate increases along the Hubble sequence Sa - Scd.

1. Introduction

Considerable controversy has surrounded the interpretation of the infrared emission from spiral galaxies following analysis of the extensive database resulting from the *Infrared Astronomical Satellite* (IRAS) survey. On the one hand, the correlations between the IRAS 40-120μm luminosity and molecular gas mass (Young et al. 1989; Sanders and Mirabel 1985) reinforce the view that the far infrared luminosity of spiral galaxies is thermal emission from dust heated by young, high mass stars. On the other hand, the propensity of galaxies with a low level of infrared emission that is energetically comparable to the optical luminosity led de Jong et al. (1984) to suggest later type stars as a significant dust heating source, particularly in those spirals which are associated with low $S_{100\mu m}/S_{60\mu m}$ color temperatures.

The emission line fluxes from ionized hydrogen provide an important measure of the number of ionizing photons and can potentially be used to constrain the number of massive stars. We have therefore compared the Hα emission line fluxes, measured for 124 spiral galaxies by Kennicutt and Kent (1983), with the IRAS data in order to address the question of whether or not the high mass stars that are required to ionize the hydrogen gas can also power the infrared emission for spiral galaxies.

2. Results

After correcting the Hα luminosities for an average 1 magnitude of extinction and extrapolating the IRAS 40-120μm luminosity to 1000μm, we find that the mean ratio of Hα to bolometric far infrared (1-1000μm) luminosity, is comparable to that expected for HII regions powered by O and B stars (Devereux and Young 1990). *The available data therefore consistently support the view that the high mass stars that are required to ionize the hydrogen gas can easily generate the*

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far infrared luminosities measured for spiral galaxies. Thus recent claims (Cox and Mezger 1989 and references therein) that there are insufficient O and B stars to power the Galactic far infrared emission indicate that either the Galaxy is anomalous or that the number of O and B stars within the Galaxy has been underestimated.

3. Discussion

Following our justification of the far infrared luminosity as a tracer of the high mass star formation rate, the all sky coverage of the IRAS survey was utilized to quantify the high mass star formation rate for a complete volume limited sample of ~ 1000 spirals selected from the *Nearby Galaxies Catalog* (Tully 1989). The spirals were segregated by Hubble type in order to elucidate potential differences in the high mass star formation rate between spirals of early (Sa-Sab) and late (Sc-Scd) types.

The analysis revealed that the distribution of far infrared luminosities is similar for early and late type spirals with a median (40-1000μm) luminosity of ~ 3×10^9 L_o (Devereux 1987). Consequently, the median present day birthrate of high mass stars is independent of spiral type. Like the star formation rates, the star formation efficiency, quantified as the ratio of far infrared luminosity to molecular gas mass, also shows no systematic dependence on Hubble type (Rengarajan and Verma 1986; Young et al 1989; Thronson et al 1989). Consequently the high mass star forming capabilities of spiral galaxies appear to be remarkably homogeneous despite the wide diversity of optical morphology. These results would appear to challenge the growing perception that the median high mass star formation rate increases along the Hubble sequence Sa-Scd (Kennicutt and Kent 1983; De Jong et al 1984; Rieke and Lebofsky 1986; Pompea and Rieke 1989).

4. Conclusion

The far infrared luminosities have been compiled for a complete volume limited sample of ~ 1000 spiral galaxies. The distribution of far infrared luminosities is similar for spirals of types Sa - Scd inclusive with a median value ~ 3×10^9 L_o. By adopting the well supported view that the far infrared luminosity is a measure of the O and B star formation rate we conclude that the median present day global birthrate of high mass stars is ~ 0.2 M_o/yr and independent of Hubble type for spirals Sa - Scd inclusive.

5. References

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