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Far Infrared-Radio Correlation in Galaxies

In-Jyh Tsay and Chung-Ming Ko
Institute of Astronomy and Department of Physics
National Central University, Chung Li, TAIWAN 32054

Abstract : Observations show that strong correlation exists between far infrared luminosities and radio continuum intensities of spiral galaxies. An extension to the standard model is presented.

Numerous radiations are emitted from galaxies, e.g., optical, x-ray, radio, far infrared, near infrared, H alpha, etc. Among different radiation, the far infrared-radio correlation is the strongest or the tightest. It spans more than four orders of magnitude in luminosity. The natural explanation is the mass-scaling effect, i.e., more massive galaxies produce more radiation in both far infrared and radio (and others for that matter). But this is only part of the answer. When the mass-scaling effect is eliminated by dividing the luminosity by mass the correlation is still there, though less tight.

The standard model--calorimeter theory--says that both far infrared and radio emissions are correlated with the supernova rate of the galaxy. The ultraviolet radiation of the supernova progenitors heats up the dusts and then re-radiates in far infrared radiation. The high energy electrons produced by the shock of the supernova remnant radiate synchrotron radiation when they encounter magnetic field in the galaxy. In normal circumstances the galaxy is opaque to ultraviolet and electrons are confined within the galaxy, hence the correlation between ultraviolet radiation and high energy electrons becomes far infrared-radio correlation.

Recently, a study shows that when the amount of cosmic ray increases, the formation rate of high mass stars increases and hence the supernova rate increases. We incorporate this feedback in a modified model and discuss some of the features of such systems.