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RADIO CONTINUUM AND CO EMISSION IN STAR-FORMING GALAXIES.

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Radio continuum images and CO-line observations have been combined to study the relationship between molecular gas and the star formation rate within the disks of 180 spiral galaxies. We find a strong correlation between these two quantities. On average, the ratio between the radio continuum and the CO emission is constant (within a factor 3) both inside the same galaxy and from galaxy to galaxy. The star formation efficiency deduced from the radio continuum depends weakly on general galaxy properties. A comparison is made with another similar analysis performed using the $H\alpha$ luminosity as star formation indicator.

The radio continuum emission at 1.4 GHz from a star-forming galaxy is mainly synchrotron radiation produced by relativistic electrons accelerated by supernovae explosions. The CO molecule luminosity and the virial mass of giant molecular clouds correlate very well in our Galaxy and in other nearby spirals. The comparison of these radio tracers provides indeed an important tool to investigate the behaviour of the star formation efficiency (SFE) within and among galaxies without the complication of dust obscuration.

Many studies have been concerned with the behaviour of the star formation process on global scales, averaged over the entire star-forming disk. To investigate the star formation law within the disks of normal galaxies, we combined the data from two public surveys: The NRAO VLA Sky Survey (NVSS, Condon et al. 1998) and the extragalactic CO survey of the Five College Radio Astronomy Observatory (FCRAO survey, Young et al. 1995). It is important to stress that we are comparing two homogeneous data set with the same angular resolution of 45″.

We express the SFE in terms of the ratio of the SRF surface density, $\Sigma_{\rm SFR}$, to the molecular gas surface density, $\Sigma_{\rm H_2}$. We consider $\Sigma_{\rm SFR}$ to be directly proportional to the radio continuum brightness at 1.4 GHz and, adopting a constant linear conversion factor between the CO luminosity and H_2 mass, we assume $\Sigma_{\rm H_2}$ to be proportional to the integrated CO intensity. In most cases, $\Sigma_{\rm SFR}$ and $\Sigma_{\rm H_2}$ present the same scaling from the galaxy center outward, resulting in a constancy of the SFE along the disk. This tight correlation holds both inside the same galaxy and from galaxy to galaxy. Figure 1 shows the spatially resolved radio Schmidt law, star formation versus molecular gas content, for all the detections in the sample. The solid line is the best fit of the composite radio Schmidt law: $\Sigma_{\rm SFR} \propto {\Sigma_{\rm H_2}}^{1.3}$. This exponent for the Schmidt law indicates a SFE which weakly increases with the SFR.

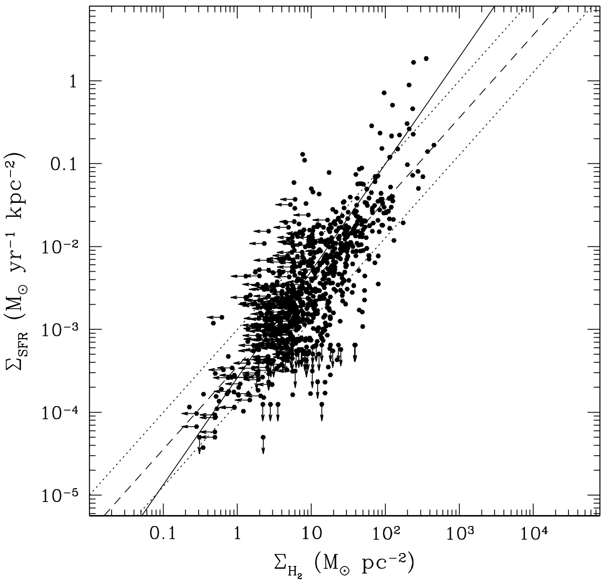

Fig. 1. Spatially resolved radio Schmidt law for all the detections in the sample. Arrows indicate upper limits at 2σ.

Considering all galaxies, the mean of log(SFE) is approximately 3.5% of the gas consumed per 10^8 yr and the rms of the distribution is slightly less than a factor of 3. SFE mean and dispersion of the sample are traced in Fig. 1 as dashed and dotted reference lines, respectively.

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