The Effect of the Large Scale Structure of the Galaxy on Star Formation Properties

David Eden, Toby J.T. Moore
Astrophysics Research Institute, Liverpool John Moores University

Abstract: The Galactic plane at l=30° contains the tangent of the Scutum-Centaurus Arm and the near end of the Long Bar of the Galaxy. The Sagittarius and Perseus Arms also run across the field in the background. We make use of the BoloCam Galactic Plane Survey (BGPS) and the Galactic Ring Survey (GRS) to find the fraction of total gas mass in dense, 1.1mm continuum traced structures and to see how this fraction varies over this field, in relation to the proximity of large-scale structures and the local environment.

Clump Formation Efficiency
The CFE is analogous to the star formation efficiency (SFE) in that it traces the mass of gas in dense clumps compared to the mass in the host molecular cloud. The CFE is a measure of the following:

\[ \frac{M_{\text{clump}}}{M_{\text{cloud}}} = \frac{1}{M_{\text{cloud}}} \int_{0}^{t} \frac{dM}{dt} \, dt \]

where \( dM/dt \) is the instantaneous clump formation rate. A high value for the CFE can indicate either a high star formation rate or a long formation timescale.

Source Distance Determination
The \(^{12}\)CO spectra at the positions of BGPS sources, as identified from the catalogue in Rosolowsky et al. (2010) were extracted from the GRS (Jackson et al., 2006). The peak velocity as well as its position in longitude and latitude were cross-referenced with the GRS cloud catalogues (Rathborne et al., 2009; Roman-Duval et al., 2009, 2010), allowing a distance to be assigned to the source. Sources with no GRS association were assigned distances using the Galactic rotation curve of Brand & Blitz (1993).

CFEs
If the l=30° region is split into three velocity components: the background Sagittarius and Perseus Arms; the tangent of the Scutum Arm and Long Bar and the foreground spur, we can determine the ratios of BGPS traced clump masses to GRS catalogued cloud masses in the respective line-of-sight component region. The median values for the individual clouds in the 3 regions are:

- Tangent Region: 3.78 ± 2.18 %
- Foreground Spur: 7.15 ± 4.63 %
- Background Arms: 3.39 ± 2.11 %

W43: a mini-starburst region?
W43 is an area of intense star formation in the l = 30° field. If W43 were to be considered a mini-starburst complex, it would be expected that the clouds within W43 would have higher CFEs. The mean CFE figures above suggest that the clouds within the tangent region are not in a different physical state than those in the background arms and foreground spur. The results of this study show that the CFEs do not change significantly between the W43 region and the tangent, foreground and background regions. This is consistent with the work of Moore et al. (2011, in prep) who, by using the ratio of infrared luminosity-to-clouds mass, found no large enhancement at the galacticentric radius of W43, whereas enhancements were found towards W49 and W51. This implies that the high SFR in W43 is mainly due to the large amount of molecular gas available as opposed to a greatly significant SFE.

Clump Mass Functions
Assuming the CMFs above the mass completeness limit to be a power law of the form \( \Delta N/\Delta M \propto M^{-\alpha} \), a fit to each CMF gives indices of \( \alpha = 1.87 \pm 0.13, 1.48 \pm 0.04 \) and 1.53 ± 0.10 for the foreground, tangent and background regions respectively. The index values for the background and tangent regions are consistent with each other, however the foreground region is found to depart at the 3-σ level. This is potential evidence for a steeper slope in the foreground, and for lower mass star formation.

References