The Earliest Stages of Star Formation: Protostars and Dense Cores

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Despite some progress, both the earliest stages of protostellar collapse and the origin of the stellar initial mass function (IMF) remain poorly understood. Recent 0.85-3 mm surveys of nearby clouds with, e.g., IRAM and JCMT have revealed pre-stellar condensations/cores that seem to be the direct progenitors of individual stars: their mass spectrum resembles the stellar IMF and some of them show spectroscopic evidence of collapse. These ground-based results are very encouraging as they suggest that the IMF is at least partly determined by cloud fragmentation. Since pre-stellar condensations and young protostars have Tbol < 30 K and emit the bulk of their luminosity between ~ 80 and ~ 350 microns, it is nevertheless clear that a large space telescope such as FIRST is needed to make further advances in this area. In particular, FIRST will provide a unique probe of the energy budget and temperature structure of pre/proto-stellar condensations. With an angular resolution at 85-300 microns comparable to, or better than, the largest ground-based millimeter radiotelescopes, the two imaging instruments of FIRST, SPIRE and PACS, will make possible much deeper surveys for such condensations in all the nearby (d < 1 kpc) cloud complexes of the Galaxy. These surveys are already considered among the top scientific priorities of the SPIRE and PACS core observing programmes. They will greatly help develop a satisfactory theory for the origin of the IMF. Follow-up spectroscopy at high resolution with the HIFI instrument will give quantitative constraints on the dynamical and chemical states of the most interesting condensations identified in the photometric surveys.