SCAMPS: THE SCUBA MASSIVE PRECLUSTER SURVEY

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ABSTRACT

We have started a large survey campaign (SCAMPS) to locate a statistical sample of massive precluster cores via their sub-mm continuum emission and to determine their physical and chemical properties. Here we present the results of the initial sub-mm continuum search carried out with the SCUBA bolometer camera on the JCMT.

Key words: stars: formation; ISM: clouds; ISM: HII regions.

1. INTRODUCTION

We currently know little about the earliest stages in the development of high-mass stars, in stark contrast to low-mass star formation where the early Class 0 and prestellar phases are relatively well-known. The earliest high-mass stage that we can conclusively identify occurs around 10^5 years after the birth of the high mass star: an ultracompact (UC) HII region, traced by bright mid/far-infrared thermal & cm-wave free-free emission (Wood & Churchwell, 1989). These objects represent an already luminous YSO that has begun to ionise and disperse its birthplace. Much observational effort is currently being expended to find earlier evolutionary stages to UC HII regions (massive protostars and YSOs), but all of the current searches base their search list upon either the IRAS or the MSX infrared surveys, e.g. (Lumsden et al., 2002; Molinari et al., 2000; Sridharan et al., 2002). The effect of this is to bias these searches towards hotter, more evolved objects that have already begun to heat their birthplaces. The earliest stages in the development of a high-mass star, analogous to low-mass pre-stellar cores, cannot be found by searches based upon IRAS and/or MSX. Here we describe a wide-field sub-mm continuum imaging survey for these earliest stages, which we term massive preclusters.

2. SCAMPS: THE SCUBA MASSIVE PRECLUSTER SURVEY

The terminology of these objects was suggested by Evans et al. (2002)) who, in a review of recent massive star formation surveys, extrapolated back from the physical conditions of candidate massive protostellar & protocluster cores to their supposed precursors. The actual term coined by Evans et al. was "massive pre-proto-cluster core" (a term chosen to encourage its disuse), which we shorten to "massive precluster" for ease of use. Massive preclusters are cores or clumps of gas and dust that will go on to form a cluster of high-mass stars but have not yet done so. They are expected to be cold ($\sim$10 K), massive ($\sim$ a few 1000 $M_\odot$), quiescent cores displaying no signposts of high-mass star formation. As high-mass stars are well-known to form in clusters these objects are described as precluster rather than as prestellar.

Why have these cores not been observed to date? Evans et al. discuss three possibilities: preclusters do not exist, they are very rare, or no appropriate searches have been made. We believe the third possibility is the most likely - these cores should not contain any embedded protostars that could be identified as bright IR sources but should instead radiate the bulk of their thermal emission in the sub-mm. Moreover, as high-mass stars are found in large OB groups and associations then we might expect that the earlier precluster phases could be found nearby known high-mass young stellar objects. Given the relatively poor resolution of IRAS and the fact that few wide-field sub-mm continuum imaging studies have been performed, it is not surprising that cold, massive preclusters have been missed so far.

In a recent SCUBA jiggle-mapping survey of 105 UC HII regions (Thompson et al. 2004, in prep) we found that a number of the mapped fields showed evidence for nearby dust cores both on the main image and also in the chopping positions. Source emission found in the chop position is removed from the image during sky-subtraction and appears as a negative "bowl"

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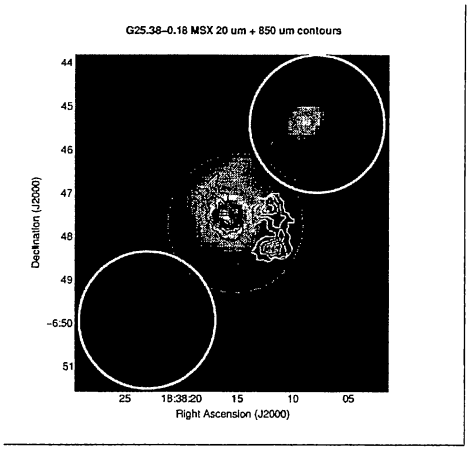

Figure 1. MSX 20μm colourscale of the G25.38−0.18 UC HII region overlaid by SCUBA 850 μm contours. Black contours represent positive features and white contours represent negative "bowls". The FOV of SCUBA is indicated by a dark-grey circle and the two chopping positions by white circles. Note that although one of the negative bowls in the SCUBA map may correspond to the bright 20 μm source to the NW, it is impossible that both do so.

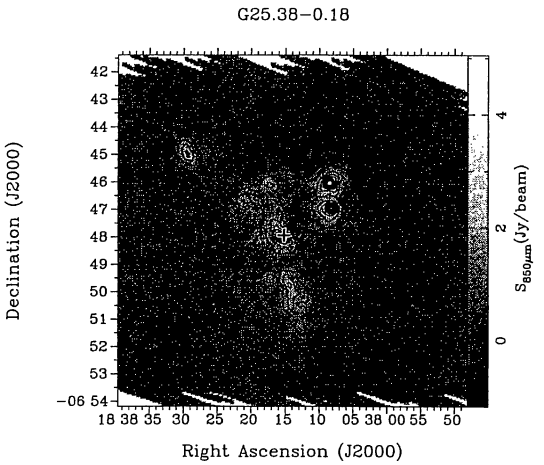

Figure 2. SCAMPS 850 μm image of the G25.38−0.18 massive star-forming region, showing the two bright sub-mm cores to the NW that were revealed as negative bowls in the earlier jiggle-map of this region.

(see Figure 1 for an example). Given the spatial scales probed by SCUBA (the 2.8' FOV of SCUBA spans 4 pc at a distance of 5 kpc), it is likely that these other cores are located within the same GMC as the UC HII regions. In order to determine both the location and physical properties of these chopping position detections we surveyed a large sample of UC HII regions using SCUBA's wide-field scan-mapping mode to image a larger extent around each UC HII region. The sub-mm continuum emission imaged by SCUBA is an excellent tracer of mass as it is usually optically thin and is emitted over a relatively wide range of temperatures. So by using SCUBA we can trace the mass in the massive star-forming regions in a largely unbiased manner. Our survey is known as SCAMPS (for **SC**UBA **M**assive **P**recluster **S**urvey) and its main aims were to: *i)* carry out an unbiased census of warm and cold massive dust cores located in the same star-forming complexes as known UC HII regions; *ii)* estimate their temperatures from the MSX & SCUBA SED and hence measure their dust masses and densities; and *iii)* identify cold massive MSX-dark precluster candidates for further study.

3. PRELIMINARY RESULTS FROM SCAMPS

During SCAMPS we imaged a total of 32 UC HII regions using SCUBA in scan-map mode, covering an area of 10′ × 10′ around each UC HII region or . ∼ 15 x 15 pc at the median distance of our sample. This is sufficient to cover at least the inner third of the GMCs within which the UC HII regions are located Blitz (1993). So far SCAMPS has been resoundingly successful - most of the imaged fields contain several associated dust cores beyond those inferred by the negative bowls in the original SCUBA jiggle-maps. An example SCAMPS 850 m image of the G25.38−0.18 region is shown in Figure 2, revealing that the environment of this UC HII region is strongly clustered and fragmented. Interestingly the brightest sub-mm core in this image is also the coldest - it is not associated with any MSX 20 μm emission and has a dust temperature <30 K. As this core also masses ∼1200 $M_\odot$ and is not associated with any known star formation tracers, it is a very good precluster candidate.

In total we have detected ∼150 massive dust cores during SCAMPS, of which 25 were found to be cold MSX-dark precluster candidates. The focus is now on detailed follow-up observations of these objects to investigate their physical properties and confirm their early evolutionary status (see article by Wyrowski et al. in this publication for details of some of this work).

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