On the Infrared Emission from SGR B2

E. E. Becklin 1 *, K. Matthews 1, G. Neugebauer 1 * and C. G. Wynn-Williams 2 **

1 320-47, California Institute of Technology, Pasadena, California 91125, USA
2 Mullard Radio Astronomy Observatory, Cavendish Laboratory, Madingley Road, Cambridge CB3 OHE, United Kingdom

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Summary. New 2.2 μ observations in the direction of Sgr B2 are at variance with Thum and Lemke's reported discovery of extended emission from the H II region. The present observations show that the emission arises from field stars almost certainly unrelated to Sgr B2. As compared to other H II regions of similar radio flux density, Sgr B2 is comparatively faint in the wavelength range 2–20 μ.

Key words: infrared — H II regions

Thum and Lemke (1975) have reported the discovery of two sources of extended 2-μ emission which they associate with the H II region Sgr B2. They attribute the emission to free-free transitions in the ionized gas and thereby derive rather low values for the extinction to the region (A_v = 10–12 mag). This result appears to be in conflict with the generally accepted picture of the Sgr B2 region which emerges at longer infrared wavelengths (e.g. Harper, 1974; Westbrook et al., 1976; Harvey et al., 1976), and with the fact that the interstellar extinction towards the central regions of the Galaxy is about 27 mag (Becklin and Neugebauer, 1968). Sgr B2 is intrinsically interesting because of its high radio luminosity, its association with a very powerful but cool far infrared source (Harper, 1974), its location close to the Galactic Center, its association with what is by far the largest known molecular cloud in the Galaxy (Scoville et al., 1975), and its apparently anomalous helium abundance (Mezger et al., 1974). It was therefore considered worth making a more detailed study of the near infrared emission from this region.

In August, 1972 a 3' × 2' area around Sgr B2 was mapped at 2.2 μ on the Mount Wilson 2.5-m telescope using a 30' diaphragm. At that time four discrete sources were found in the region, but none of them appeared to coincide with any known feature in Sgr B2. In June, 1976 a 3.5' × 4' region centered on Sgr B2 was mapped at 2.2 μ with an InSb detector and a 15' diaphragm on the Palomar 5-m telescope. To reduce confusion, observations were made by chopping the sky against an internal blackbody source, rather than by chopping between two positions in the sky. More than 30 discrete sources stronger than 10 mag (60 mJy) were found, but no extended emission stronger than about 80 mJy in the 15' beam was seen. At this resolution and sensitivity the limit on extended emission is set by the source confusion level.

Limitations of observing time prevented examination of all 30 sources in detail, but fluxes, sizes and positions of the six brightest objects were determined using a 5' diaphragm and a 775 chopper spacing. The results are in Table 1 and Figure 1. All the objects appeared pointlike with a diameter of considerably less than 5', and none coincided with any known compact H II component (Martin and Downes, 1972; Balick and Sanders, 1974), OH source (Raimond and Eliasson, 1969), or any visible star. All the sources lie outside the 50% contour of both the 1-mm emission (Westbrook et al., 1976), and the 53-μ emission (Harvey et al., 1976).

Comparison of the infrared colors in Table 1 with the standard interstellar extinction curves (Becklin and Neugebauer, 1968) indicate that all the objects have colors that are typical of stars reddened by between 10 and 35 mag of visual extinction. Since there is no direct evidence that any of these sources is physically associated with Sgr B2, it seems more likely that they are all unrelated field stars at an unknown distance along the line of sight to the H II region. The nature of the fainter objects in our survey has not been specifically checked, but since they do not obviously cluster towards the center of Sgr B2, most of them are presumably also unrelated objects.

The space density of faint 2.2-μ objects in the general vicinity of the Galactic Center may be estimated very
approximately by extrapolation of Becklin's (1968) 2.2-μm source counts. These indicate a surface density of 0.03 sources (arc min)−2 above a level of 1.6 Jy. Extrapolation by a 3/2 power law would lead to a prediction of 3.4 sources above a level of 400 mJy and 58 above a level of 60 mJy in the 14 (arc min)−2 area of Figure 1 as opposed to the 5 and approximately 30 actually observed. Given the uncertainties in the extrapolation it may therefore be concluded that there is no evidence for a statistical excess of 2.2-μm sources in the direction of Sgr B2.

The brightest of the compact H II regions found by Martin and Downes (1972) is MD4, to which they attribute 8 Jy at 5 GHz. There are several confused 2.2-μm objects visible on our scans close to this position, but a firm upper limit of 160 mJy can be placed on any 2.2-μm emission from MD4. Following Wynn-Williams et al. (1972) a lower limit of A_v = 30 mag can therefore be placed on the visual extinction in front of this part of Sgr B2.

Thum and Lemke's paper was based on a single declination scan at RA 17h44m10s. Comparison of positions and flux densities indicates that their source NIR-2 is a combination of our sources IRS 3 and IRS 5, while their source NIR-1 is mainly attributable to our IRS 4 source. Six other sources at the 50–100 mJy level may also have been included in their scan. Their conclusion that the sources are extended on a scale of 1–2 may be an artifact of the limited number of samples, and the relatively large size of the diaphragm.

In August, 1972 we also mapped the central parts of Sgr B2 at 10 μm with a 10″ diaphragm on the Mount Wilson 2.5-m telescope. In September of the same year a similar region was mapped at 20 μm using a 10″ × 30″ diaphragm on the Las Campanas 1-m telescope in Chile. No sources above a level of 90 Jy at 10 μm, or 250 Jy at 20 μm were found within 1' of the far infrared peak. Although these and the new 2-μm limit are not particularly deep, they demonstrate that Sgr B2 does not have associated with it any discrete infrared sources with flux densities as large as those in W51, an H II region with a distance and radio flux density about the same as Sgr B2. The fact that our 20-μm limit is a factor of 2.7 below the value of 670 ± 120 Jy measured by Lemke and Low (1972) with a 1' beam may indicate that at this wavelength the emission from Sgr B2 is extended on a scale of at least 30′.

The faintness of Sgr B2 between 2 μm and 20 μm is perhaps not so surprising when considered in conjunction with the 30 μm – 1 mm observations. Harper (1974) showed that the infrared source associated with Sgr B2, despite its large total infrared luminosity, has a much lower color temperature than most sources associated with H II regions; consequently, a small relative flux density shortward of 30 μm is not unexpected. The faintness at these wavelengths is very probably due to extinction by part or all of the Sgr B2 molecular cloud. The column density of the latter is so large (Scoville et al., 1975; Westbrook et al., 1976) that it potentially could produce a very significant amount of infrared extinction.

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