THE PROBABLE EXTRAGALACTIC NATURE OF SOME LOW SURFACE BRIGHTNESS CLOUDS AT HIGH GALACTIC LATITUDE

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Abstract. Low surface brightness clouds observed at optical, infrared, and radio wavelengths are discussed. We present evidence that some clouds at high galactic latitudes are associated with the Local Group, M81, and possibly even with higher redshift extragalactic objects.

Low temperature clouds at high latitude must affect at some level the short wavelength side of the cosmic background radiation. If some of these clouds are extragalactic there should be a further effect on the interpretation of CBR measures.

1. Introduction

It has been apparent since the advent of the Palomar Sky Survey (PSS) that there exist certain very low surface brightness clouds and filaments at high galactic latitudes (Lynds, 1965; van den Bergh, 1966). It was generally assumed they were entirely due to local gas and dust in the plane of the Milky Way (see e.g., Sandage, 1976). Certain features, however, were proposed to be associated with more distant galaxies which showed ejection activity (Arp and Kormendy, 1972). When all sky hydrogen (H I) maps became available (e.g., Heiles, 1976; Hulsbosch, 1983) it was evident that most of that H I belonged to the disk of our own Milky Way Galaxy. Nevertheless some investigators argued that, even in the low redshift range surveyed, certain smaller clouds were more distant and belonged in our Local Group of galaxies or in other nearby groups (Verschuur, 1969; Arp, 1985). Most recently low surface brightness clouds have been observed at infrared wavelengths, particularly at 60 and 100$\mu$m in the IRAS survey (see e.g., review by Burton et al., 1986). There are not, however, spectra available for all these optical or infrared clouds (also commonly referred to as ‘cirrus’) which give their redshift or information on the material of which they are composed. There is generally no direct evidence that any specific cloud is galactic or extragalactic.

The 100$\mu$m clouds generally extend to higher galactic latitudes than either the molecular clouds or the gaseous CO. Burton et al. note ‘The larger thickness of the dust layer is, to us, an unexpected result’. This result is further supported by the fact that exponential fits of a dust layer assumed to be 120pc thick are good except toward higher latitudes where there is a small systematic excess (Burton et al., 1986; Figure 8). This would

suggest a small amount of dust is detected at higher galactic latitudes which does not belong to the plane of our Milky Way Galaxy.

Another property which might lead us to expect that some high latitude infrared clouds are extragalactic is the scale and isolation of some of them. Dust in the plane of our own Galaxy which appears at high galactic latitude must be quite near the solar neighbourhood. Such clouds should appear quite large and connected in complexes of rather larger angular extent on the sky. This is in fact how many of the high latitude clouds actually appear. But there are some considerably smaller clouds which appear relatively isolated. Examples can be seen in Burton et al. (1986, Figure 1). In these figures the large and small Magellanic clouds at $l = 280^\circ$, $b = -33^\circ$ and $l = 303^\circ$, $b = -44^\circ$ are conspicuous. Some smaller clouds seen in the direction of the local group of galaxies (M31: $l = 121^\circ$, $b = -22^\circ$) are also candidates for infrared clouds outside our own Galaxy.

It is important to note that Rudnicki et al. (1989) review the evidence for an extragalactic cloud which is identified by both absorption of galaxy counts and confirmed by 100$\mu$ infrared emission which concentrates over the same $20 \times 15^\circ$ area just south of the Coma Cluster of Galaxies. Murawski (1983) concluded the cloud could be located anywhere from just outside our Galaxy to 100 Mpc away.

We here present further evidence that extragalactic dust clouds exist and are associated with galaxies of various redshifts. Tests of such associations are proposed which would utilize existing survey data.

2. The Ring around M81

The region around M81 exemplifies the difficulty of identifying and understanding the nature of low surface brightness material. A low surface brightness optical ring was discovered around the northern end of M81 using deep Schmidt plates (Arp, 1965). The discovery photograph of this is shown in Figure 1. Larger area Schmidt plates by Sandage (1976) revealed what was presumably galactic ‘cirrus’ over large regions near M81 ($b = +44^\circ$). It was shown that the surface brightness of most of this material was consistent with scattering of light from the galactic disk ~100 pc distant. The ring detected by Arp, however, is somewhat brighter and bluer than much of the other nearby cirrus. The ring also exhibits a symmetry about the end of the M81 disk, in the direction of M82, that would have to be ascribed to chance if it is unrelated to the galaxy.

Gottesman and Weliachew (1975) observed emission within the optical boundaries of the ring at 21 cm and calculated an H I mass of $\sim 10^9 \, M_\odot$ for it at the distance of M81. This is $\sim 16\%$ of the H I mass of M81. Rotst and Shane (1975) derived a factor 2 lower H I mass for the ring structure. Utilizing deep photographs with the Soviet 6-m reflector Efremov et al. (1986) now report blue diffuse and star-like objects resolved in the ring. They conclude the ring is composed of young stars and star clusters associated with the previously detected H I. They also argue, as Arp did in 1965, that the straight dust absorption bands projected onto the northern end of M81 are due to dust in the ring since parts of it should be situated between the observer and M81.