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Dust in the Galactic Supernova Remnant W44

Eleni Tsiakaliari, Haley Gomez, Mikako Matsuura
Cardiff University

1. Abstract: Supernovae were formerly thought to be major dust destroyers but recent studies suggest that dust formation occurs in the ejecta (Gall et al 2014, Matsuura et al 2015). Hence, supernovae could account for the dust enrichment of the Interstellar Medium (ISM) of galaxies. Herschel Space Observatory's data of the galactic remnant W44 were used to study the dust enclosed within it along with its interaction with the surrounding ISM. Initial results are presented here.

2. Introduction

Supernovae have been the subject of recent astronomy studies because they are considered to be the site of dust formation. Observations of supernovae and supernova remnants such as the Crab Nebula and SN1987A, have shown that there can be dust in the filaments (Gomez et al 2012) and also at the centre of the ejecta (Matsuura et al 2015).

3. The Supernova Remnant W44

W44 is a Galactic supernova remnant, with an age of approximately 20,000 years (Cardillo et al, 2014) and a distance of 3.3 kpc (Su et al. 2013). It has a pulsar, PSR B1853+ 01, detected in the south part of the remnant (Frail et al. 1996). It is a mixed morphology remnant. This means that it has a bright X-ray centre, a clear radio shell but no X-ray shell. (R.L. Shelton et al.)

4. Herschel Space Observatory's observations

The remnant has been observed with the *Herschel* space observatory as part of the Galactic Plane Survey, Hi-Gal (Molinari et al. 2016). It covers 70μm, 160μm (PACS) and 250μm, 350μm and 500μm (SPIRE). The remnant is clearly detected at 70μm but then it gets progressively worse at longer wavelengths. Figures 1-3 show Herschel images of the remnant. The units are *MJy/sr*.

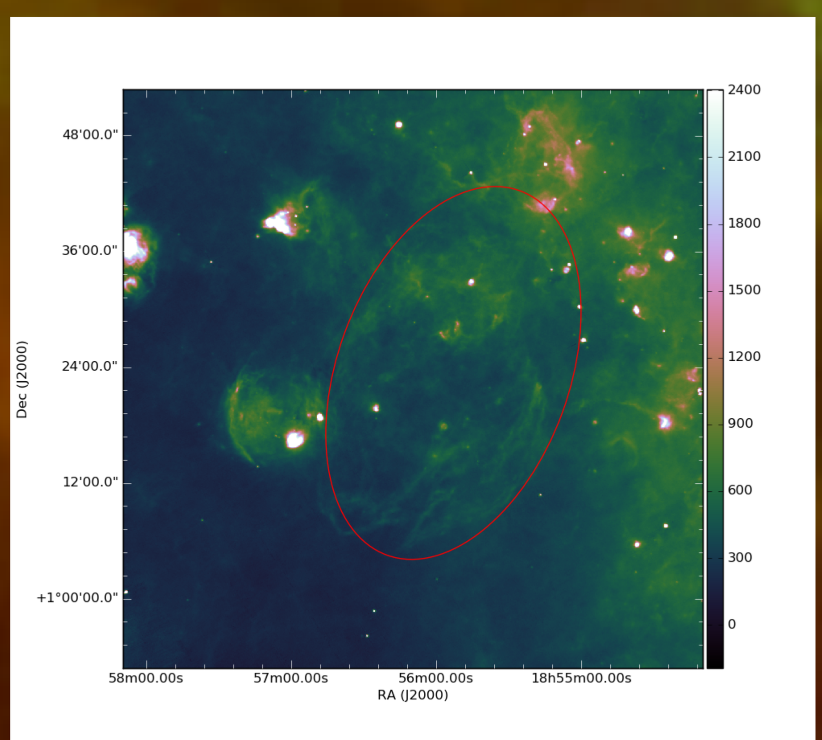

Figure 1: The remnant at 70μm. There is clear emission from supernova remnant W44 at this wavelength.

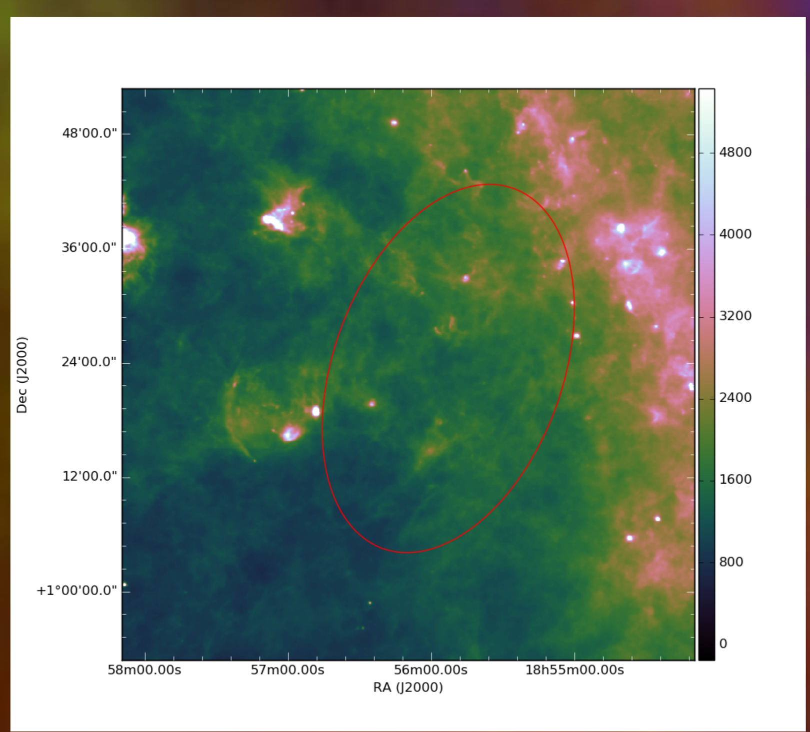

Figure 2: The SNR is marginally detected at 160μm. A molecular cloud is found at the left of the ellipse, which the remnant is interacting with.

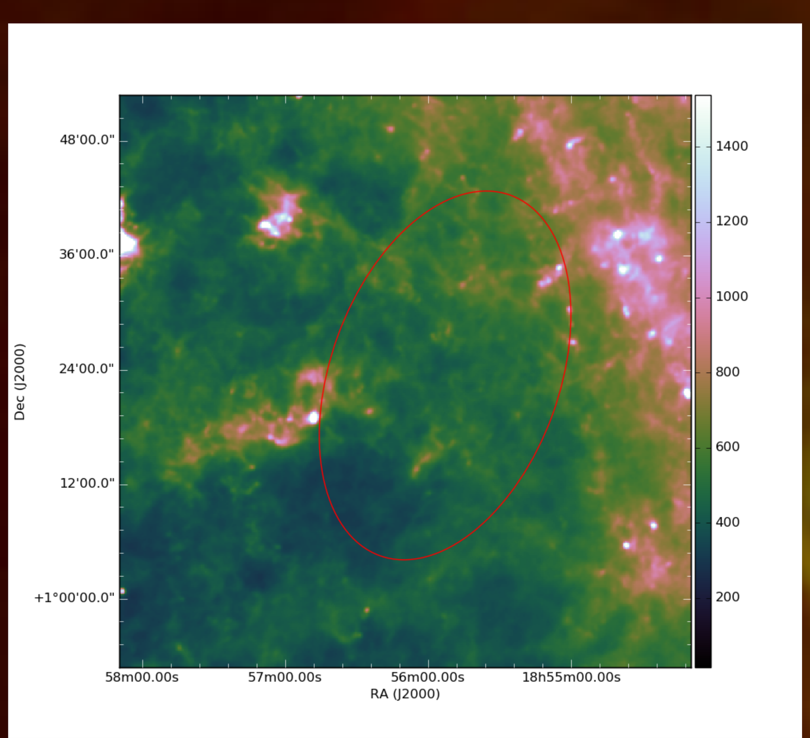

Figure 3: The 350μm image, where the shell like structure of the SNR is not discernible at all.

5. Ratio maps

In order to detect any temperature variations in the remnant, ratio maps were plotted using the *Herschel* PACS and SPIRE images of the remnant. Figures 4 and 5 demonstrate filamentary structures associated with the SNR which tends to have higher temperature than the surrounding ISM.

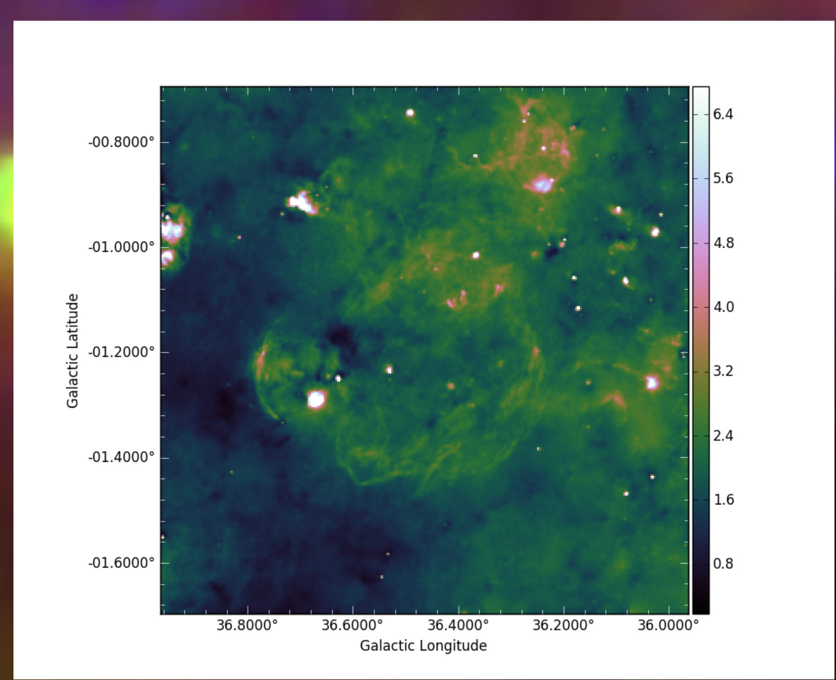

Figure 4: : 70μm divided by 500μm

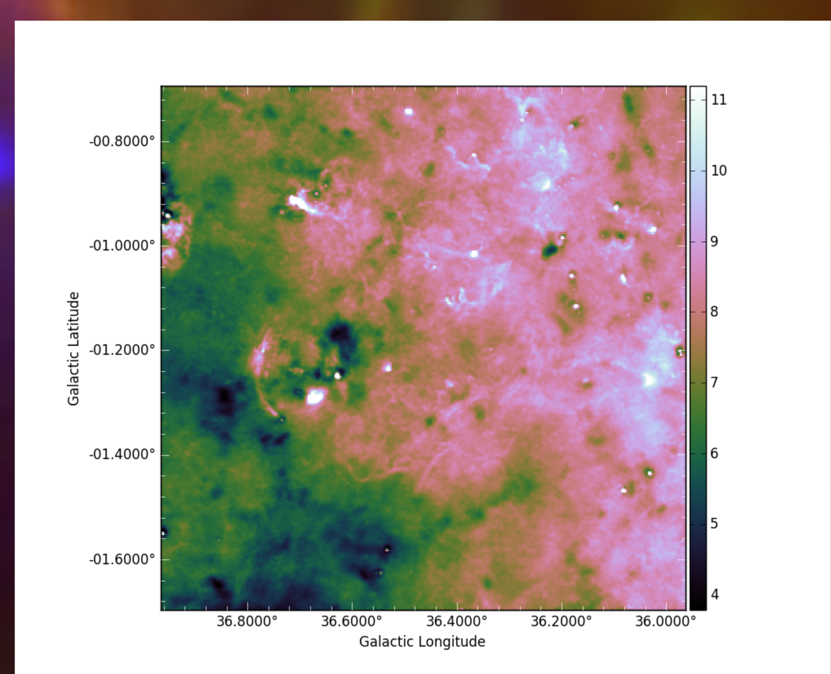

Figure 5: 160μm divided by 500μm

6. References.

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