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Multicolour broadband study of a lenticular galaxy : NGC 4753

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Abstract. Based on VBT observations, we report multicolour broadband study of a lenticular galaxy, NGC 4753 with prominent dust lanes. The extinction curve derived for NGC 4753 is similar to the Galactic extinction curve. The dust mass estimated from optical extinction is 1.51 x 10^5 $M_\odot$ and from the far infrared fluxes observed with Infrared Astronomical Satellite (IRAS) is 3.46 x 10^5 $M_\odot$. The dust observed within NGC 4753 can be argued to be internal in origin.

Key words : galaxies, dust extinction, FIR

1. Introduction

Presence of dust in early-type galaxies is the rule rather than an exception. Cool inter-stellar dust has been observed by IRAS (Jura 1989) and by means of optical extinction (Goudfrooij et al. 1994a). The study of these galaxies provides important clues to the origin, nature and fate of the observed dust. In particular, dusty early-type galaxies provide suitable environment to study the nature of extra-galactic dust grains, either via their far infrared (FIR) emission or optical extinction. We present a summary of analysis of dust properties of an SO galaxy NGC 4753 with very prominent dust lanes. Details are given in Dewangan et al. (1999).

2. Observation, analysis and results

NGC 4753 was observed in B, V and R bands with the Vainu Bappu Telescope (VBT) on the night of March, 13, 1996 under photometric conditions. The seeing was in the range 2.1" – 2.6″. The basic reductions of CCD images were performed using the IRAF software package. The presence of dust lanes or patches within NGC 4753 was inferred from the broad-band images as severe departures of isophotes from the nearly elliptical shapes, and from the $B - R$ colour image with the redder regions being due to the presence of dust. Based on optical extinction and employing grain size distribution of Mathis et al. (1977) for spherical grains that are composed of either graphite or silicates with equal abundances, we derived the total dust mass of NGC 4753 to be 1.51 x 10^5 $M_\odot$. The method is outlined in Goudfrooij et al. (1994b).

NGC 4753 was detected as a point source in the IRAS survery in all four bands 12μm, 25μm, 60μm and 100μm. The dust temperature was determined to be 30.4 K based on the ratio of flux densities at 100μm and 60μm under the assumption that the FIR emission from the dust grains within NGC 4753 is govbered by an emissivity law where emissivity is proportional to λ^{-1} at wavelengths $\leq 200\mu$m. We have estimated the dust mass of NGC 4753 based on FIR flux density $f(\nu)$, dust temperature T_d, dust emissivity $Q(\nu)$. The derived cool dust mass is 3.46 X $10^5 M_\odot$.

3. Discussion

The dust mass of NGC 4753 derived from optical extinction and from IRAS flux densities are different. The ratio of the two dust masses, $\frac{M_{d,\,IRAS}}{M_{d,\,optical}}$ is 2.28. The discrepancy can be attributed to the fact that the dust mass derived from optical extinction is a lower limit because the extinction is observed only when the dust is in front of the stars and confined to somewhat condensed clouds. The dust is probably distributed between stars or stellar systems.

The origin of observed interstellar dust can be either internal (e.g. due to mass loss from stars) or external (galaxy-galaxy interaction or merger). The total mass loss from stars can be estimated if we assume that about half of the total $12\mu m$ flux arises from circumstellar dust in mass losing red giants (see Soifer et al. 1986). Assuming that mass loss from red giants is driven by radiation pressure, we estimate the total mass loss rate from mass losing stars within NGC 4753 to be $\simeq 1.3 \times 10^{-3} M_\odot\, yr^{-1}$. Taking gas to dust ratio in the circumstellar shells of red giant stars to be 100 : 1 by mass, with a factor of 2-3 uncertainty, the total dust mass accumulated within the life time ($\simeq 10^9 - 10^{10} yrs$) of the galaxy is $\simeq 10^4 - 10^5 M_\odot$. Given the uncertainty in the gas to dust ratio, the mass loss rate indicates that it can account for the observed dust within NGC 4753 suggesting an internal origin of dust.

In order to investigate the fate of cool dust, we examine the possibility of star formation within NGC 4753. The galaxy NGC 4753 occupies an intermediate position in the phenomenological IRAS color-color diagram of Helou (1986), where both the cirrus component and active star forming regions contribute to the total FIR emission. However, the FIR emission from active star forming regions is less than 50% of the total FIR luminosity, so that the total FIR emission of NGC 4753 cannot be interpreted as due to current star formation. Following Thronson & Telesco (1980), we estimate the current star formation rate of NGC 4753, averaged over past $2 \times 10^6\, yrs$ to be less than $0.21 M_\odot\, yr^{-1}$ from total FIR luminosity from active regions. As discussed above, the cirrus component of dust within NGC 4753 contributes more than 50% to the total FIR luminosity, hence significant amount of dust within NGC 4753 is in the form of cirrus. This suggests that the cirrus clouds are sufficiently dense so that they are not destroyed by ionizing radiations or by sputtering. On the other hand, these regions are not sufficiently dense to lead to gravitational instability to form stars.

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