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Dust in an extragalactic environment : The case of NGC 2907

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Abstract. We have carried out a detailed CCD surface photometric analysis of the lenticular galaxy NGC 2907, containing multiple dust lanes, with the objective of studying properties of dust in an extragalactic environment. Measurements of extinction in the optical B, V, R, and I bands indicate that the wavelength dependence of dust extinction is similar to that of the Milky Way. However, the R_V value for NGC 2907 turns out to be smaller than the canonical Galactic value of 3.1, suggesting that the dust grains responsible for the optical extinction are smaller than that in the Milky Way.

Key words : Galaxies : S0, early type – NGC 2907, interstellar matter (ISM), interstellar dust

1. Introduction

Our current project is aimed at a multi-frequency study of a sample of early-type galaxies to determine the distribution and the morphology of the multi-phase form of the ISM. We are also interested in studying the possible origin of the ISM. In the present paper we report the detailed study of the dust properties in NGC 2907, which is a major-axis, multiple dust-lane lenticular galaxy containing an appreciable amount of dust. The dust extends up to 46″ (7.4 kpc) on either sides of the nucleus. The H_I content extends almost parallel to the dust lane.

2. Observations and Data Reduction

Observations of NGC 2907 were carried out using the 1m telescope of UPSO, Naini Tal during December 1999 in Johnson BVRI broad band filters. Data reduction work was carried out by following standard tasks available within IRAF (Mahabal 1998, Sahu et al. 1998). In order to study the dust distribution and other features embedded in NGC 2907, color-index maps (Fig. 1(A)) were generated. Ellipses were fitted to the isophotes of the galaxy image using *ellipse*

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task available in STSDAS (Jedrzewski 1987), profiles of various parameters of fitted ellipses are shown in Figure 1(B). To quantify the amount of dust and to study its properties, extinction maps were made (Brosch et al. 1991, Goudfrooij 1994), from which obscursion of the star light due to dust was estimated. The ratio of total to selective extinction R_λ (= $A_\lambda/E(B-V)$) values thus obtained are listed in Table 1. Fig.1 (C) shows the extinction curves for the Milky Way (dotted line) and for NGC 2907 (solid line).

From Fig.1(C) it is clear that, the extinction curve for NGC 2907 shows a shift to the right along $1/\lambda$ axis, implying that the dust grains which are responsible for producing extinction of optical light have smaller size as compared to those in the Milky Way. The extinction of optical light can be related to the grain number density (n_d) and the grain size (a) and can be expressed as,

$$A_\lambda = 1.086 n_d \pi a^2 Q_e \qquad (1)$$

where Q_e specifies the efficiency with which the grains attenuate star light.

The relative grain size can be estimated by shifting the observed extinction curve along the $1/\lambda$ axis until the best match with the Milky Way extinction curve was achieved. Here we assume that the dust in the Milky Way have spherical geometry and is composed of either graphite or dirty silicates with grain radius equal to $0.05\mu m$ and $0.1\mu m$ respectively. The relative grain size $< a > /a_{Gal}$ of the dust particles in NGC2907 turns out to be 0.77 ± 0.003 times that in the Milky Way.

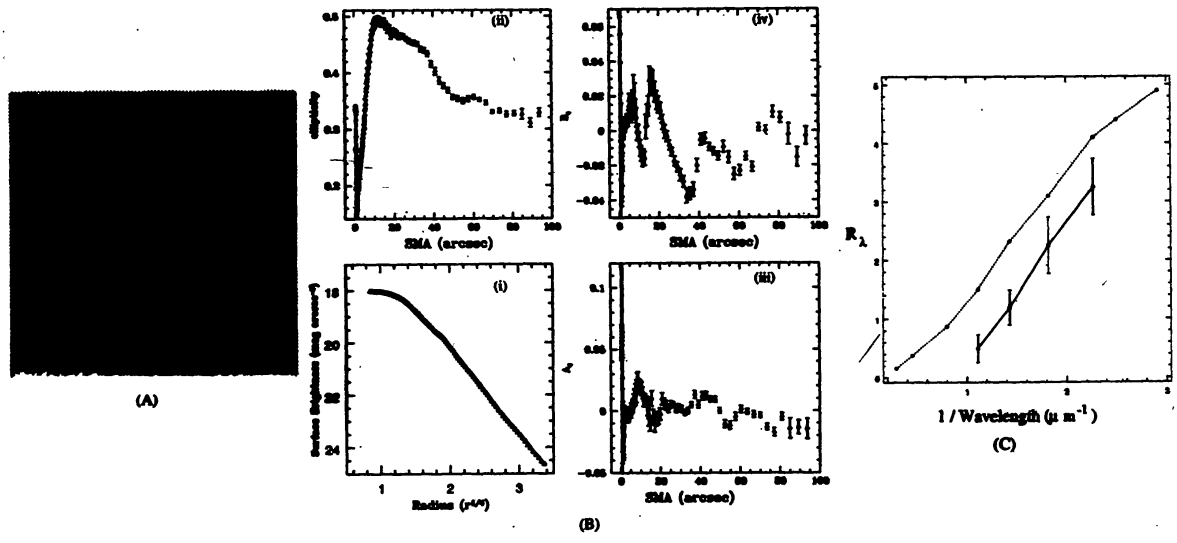

Figure 1. (A) B-V Color map of NGC 2907, indicating two clearly resolved dust lanes along major axis and fainters lanes on one side, (B) Profiles of ellipse fitted parameters for NGC 2907 (i) surface brightness, (ii) ellipticity, (iii) A_4, (iv) B_4 coefficients, (C) R_λ against λ^{-1} for NGC 2907 (solid line), and for the Milky Way (dotted line).

Table 1. R_λ values reported for the Milky Way and derived for NGC 2907 for different filters.

Band	λ (μm)	$1/\lambda$ (μm^{-1})	R_λ (Milky Way)	R_λ (NGC 2907)
K	2.2	0.45	0.38	–
J	1.25	0.80	0.87	–
I	0.90	1.11	1.50	0.50 ± 0.23
R	0.70	1.43	2.32	1.19 ± 0.30
V	0.55	1.82	3.10	2.25 ± 0.48
B	0.44	2.27	4.10	3.25 ± 0.48
–	0.40	2.50	4.40	–

3. Results and Discussion

The relative grain size of the dust in NGC 2907 is about 0.77 ± 0.03 times that in the Milky Way. The dust mass estimated from optical extinction is ~ 1.1 x $10^5 M_\odot$. The dust mass and its temperature using FIR flux at 60μm and at 100μm comes out to be 3.5 x $10^5 M_\odot$ and 32K respectively. From optical color excess (Bohlin et al. 1978) we estimate the neutral hydrogen (H_I) mass to be about 1.0 x $10^9 M_\odot$, whereas the mass obtained from 21 cm (H_I) data is 2.5 x $10^9 M_\odot$. The ratio of $M_{d,optical}/M_{d,FIR}$ ~ 0.32, implying that the dust detected in FIR is more than that in optical.

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