# OPTICAL EVIDENCE FOR A DUST RING IN THE CENTRE OF M 82 AND (OR?) A FLAT STAR BURST REGION

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ABSTRACT. A dust ring surrounds the central starburst region in M 82, resulting in strong additional reddening of light emerging near the equator. The starburst is contained in a flattened, optically thick region inside this ring. The concentration of scattered light near the minor axis is explained as the combined action of the $\cos\vartheta$-emission-law of the flat source and the shadowing by the ring. The dust ring may be spatially coincident with the CO-ring.

## 1. INTRODUCTION

The centre of the irregular galaxy M 82, where violent star formation is going on, is heavily obscured, $A_V \approx 25$ mag (Rieke et al. 1980). Light emerges near the minor axis and is scattered at dust in the outskirts of this galaxy, similar to the (much smaller) galactic bipolar nebulae. A ring or torus of dust is, thus, expected around the central light source in M 82.

## 2. EVIDENCE FOR A DUST RING

2.1. There is nearly no scattered light near the major axis, but much near the minor axis. Above the centre, a flat minimum divides this scattered light into a "northern" and a "southern" part (Fig. 1).
2.2. The reddening of the scattered light - Fig. 1 - is smallest far up and down the minor axis, moderately strong at some distance from it, and very strong in the region of the "shadow" just above the major axis.
Both observations (1) and (2) point to a dust ring seen nearly edge on. Since the minimum is some 20" north, the axis of the ring must be tilted away from us there. From the curvature of the outer parts of the $24^m$-isophote in



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Fig. 1, interpreted as an effect of the ring's shadow, the inclination is 8 ± 2 degrees (by chance, nearly the same value as found by Lynds and Sandage 1963).

2.3. The diameter of the ring.

An approximate value is given by the diameter of the waist of the intensity distribution in Fig. 1; $2r \approx 30"$. A lower limit is estimated from the gradient of the rotation curve of $H_\alpha$ in the central region ("A", after O'CM, 1978). Proposing that we see either light scattered at the edge of the dust torus or light from the outermost parts of an optically thick star-dust mixture in pure rotation, the gradient indicates the circular velocity at this distance. We get - see Fig. 2 - $r > 8$ ... 11", depending on our choice of the two curves.

2.4. The thickness of the ring.

- To inhibit the direct view to the centre, the dust torus must have a half-thickness of at least $t = r*\tan 8° + s$, r being the radial distance of the ring from the centre and s the "radius" of the light source. From $r > 8"$, $t > 1".1 + s$.
- To give a distinct shadow, the ring must be thicker or about equal to the diameter of the light source. If both are equal, the observed diameter of the shadow (8"), leads to t = 4".

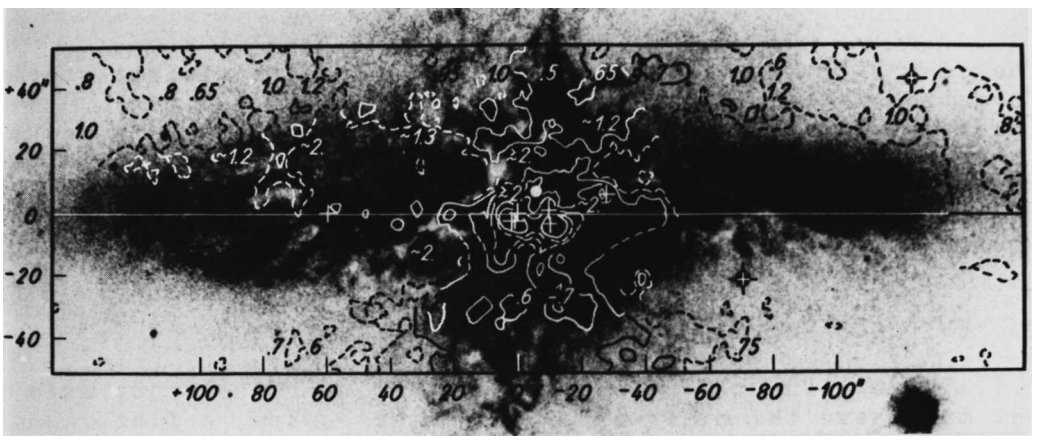


Fig. 1. Isophotes of scattered blue light from the central source. Numbers are (B-V) of scattered light, indicative of the relative reddening. Isophotes are: $24^m$ (dashed, incomplete for clarity), $23^m$, $22^m$, $21^m.5$, $21^m$, $20^m.5$; interpolated parts near the centre are dashed. - Combination of figures 5, 6, 7 in Notni and Bronkalla 1984, superposed on a photo in $H_\alpha$ (+continuum, $\Delta\lambda$ = 80 Å, by Lynds and Sandage, 1963).

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## 3. THE FLAT SOURCE

Since $t < r$ from 2.3 and 2.4, maybe even $t \ll r$, the volume available to the light source is "flat". A very probable arrangement is a luminous disk surrounded by a ring of dust. Such a flat region, if it is optical thick, will mimic a "$\cos \vartheta$-law" of obscuration even without any dust (it looks fainter edge-on). The "dust-ring" may be just the outermost dusty and less processed part of a flat region where the star burst is going on.

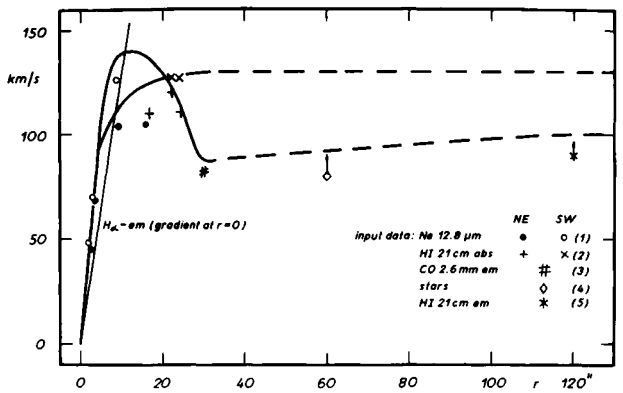


Fig. 2. Crude mean rotation curve of M 82. The two free-hand curves indicate the possible error limits.
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## 4. POSSIBLE ASSOCIATIONS WITH OTHER KNOWN FEATURES

Flat or ringlike structures at the appropriate place have been seen at many frequencies, representing many types of objects. The most fitting coincidence with our "dust ring", both positionally and physically, is the CO-ring (Nakai et al. 1986).

References

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