OBSERVATIONS OF THE ORION NEBULA IN
Hα, [NII] AND Hβ LINES

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Abstract. Monochromatic photographs of the Orion Nebula taken through narrow bandpass interference filters (Δλ = 10 Å) centred on Hα, Hβ and [NII] lines are presented. Ratio contours of Hα/[NII] and Hα/Hβ are derived. They enable a detailed study of the point-to-point variation in ionization structure and temperature throughout the nebula.

Dust located within the ionized gas is studied from the Hα/Hβ ratio which varies from point to point over the nebula. Its strongest concentration, apart in the obvious 'dark bay', occurs in a shell surrounding the exciting stars, with about 2' of diameter. Close to θ1 Ori the Hα/Hβ ratio, corrected for interstellar reddening, is about 3.0 in good agreement with the predicted value (Brocklehurst, 1971). To account for these measures, the following arguments are proposed:

(1) Dust grains are completely or partially destroyed in region close to the exciting stars.
(2) Radiation pressure and stellar wind push the remaining dust up to some equilibrium distance outwards. The consequence of this action is obviously the formation of a 'dust mantle' which is seen as a ring in projection.

1. Introduction

The presence of dust in gaseous nebulae strongly modifies the ionization structure and emission properties of the photoionized gas: (i) enhancement of optical forbidden lines of low excitation species such as nitrogen, sulfur; (ii) deviation of the Balmer decrement from theoretical predictions and, for example, the observed Balmer discontinuity is smaller than in the case of pure atomic processes (Hua, 1974a, b); (iii) variation of the ratio of He/H which is well correlated with the high infrared flux excess (Churchwell et al., 1974); (iv) discrepancy between radio/Balmer continuum and forbidden line temperature (T_e) determinations suggesting fluctuations of T_e across the nebula.

Most optical studies of gaseous nebulae have been made in order to determine surface brightness, electron temperature, chemical composition (Peimbert and Torres-Peimbert, 1977) dust content and location (O'Dell and Hubbard, 1965; Münch and Persson, 1971). Some of them were carried out with moderate dispersion scanners, others with narrow or wide bandwidth filters. One should, however, be cautious when interpreting physical parameters of the emitting gas because of the influence of dust. In addition, distinction must be made between the case of dust mixed with nebular gas and the case of dust located outside the nebula. Both cases seem to coexist in most H II regions.

The Orion Nebula (NGC 1976-M42) is the most suitable gaseous nebula for this kind of investigation owing to several respects: nebula and stars are bright enough to be
extensively observed at all wavelengths, and since the pioneer work of Greenstein and Henyey (1939), number of studies have been investigated to measure polarization, extinction, dust to gas ratio throughout the nebula. For instance, it has been pointed out that interstellar extinction in M42 has a wavelength dependence different from the other regions of the sky, the anomalous reddening law being caused by circumstellar envelopes (Johnson, 1967). One should, however, notice that the Whitford reddening law only applies for the case of dust located between the nebula and the observer, and not for the case of dust mixed with nebular gas.

Furthermore, monochromatic photographs of M42 taken in the emission lines or in the adjacent continua exhibit strikingly different structures (Wurm and Rosino, 1959; Courtès and Viton, 1967), indicating the presence of small-scale variations of the effective thickness. An useful step forwards the knowledge of these features would be to reanalyse the distribution of dust within the ionized gas from the $H\alpha/H\beta$ ratio across the nebula, which implies an additional correction of 'self-reddening' due to internal extinction.

2. Observations and Results

Monochromatic photographs were taken through narrow bandpass interference filters centred on the $H\alpha$, $H\beta$, $[N\text{II}] \lambda 6584$ lines at the Newtonian f/6 focus of the 80 cm telescope of the Haute Provence Observatory (Figures 1, 2, and 3). Kodak 103aE plates are used for $H\alpha$ and $[N\text{II}]$ and IIa0 for $H\beta$. Several plates were obtained for each line with increasing exposure time. Bandpass and transmission of interference filters and adopted exposure are given in legends of Figures 1, 2, and 3. Images of $H\alpha$ and $H\beta$ are quite similar except for the 'dark bay' region, whereas differences between $H\beta$ and $[N\text{II}]$

![Image](image_url)

Fig. 1. $H\alpha$ filter ($\Delta \lambda = 9.1$ Å, peak transmission = 0.6) combined with 103aE plate. Exposure: 7" telescope 80 cm f/6. Identifying stars are marked by the letters C and D. North is up, east to the left. CD $\approx 4.5$. 