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Facilities: VLT:Yepun (MUSE); VLA

Extinction and scattering of nebular emission in Orion

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Abstract

I compare several different methods for estimating the dust extinction of diffuse emission from H II regions. Using archival data for the Orion Nebula, I show that apparent discrepancies between the different methods are powerful diagnostics of (1) emission line scattering from dusty PDRs; (2) the presence of dust layers sandwiched between two emitting gas layers; and (3) the presence of deeply embedded ionized gas that is invisible at optical and near-infrared wavelengths.

Keywords: Atomic physics; Radiative transfer; Photodissociation regions

1. INTRODUCTION

2. OTHER MEASURES OF EXTINCTION

2.1. *Diffuse interstellar bands*

5781 Å is the cleanest. There is also 6283 Å, which is stronger, but it is affected by the telluric O_2 absorption.

2.2. *Forbidden metal doublets*

We can use two lines that share an upper level. Small wavelength range, but high S/N and rock-solid intrinsic ratio.

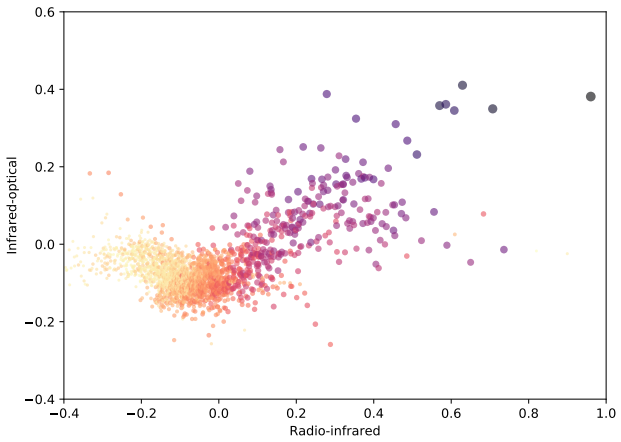

Figure 1. Scatter plot of the infrared/optical extinction anomaly versus the radio/infrared extinction anomaly. Plot symbol color and size indicate the optical–radio extinction (larger values are darker and larger).

[O III] 4959 and 5007 Å is a 1% change in wavelength. We see about a 1% variation in the ratio.

[Ar III] 7751 and 7136 Å is a 9% change in wavelength. We see about a 15% variation in the ratio. We also see scattering in the Bar PDR (reduction in reddening).

These give the gradient, $dA_\lambda/d\lambda$

Possibly affected by intermediate-scale structure (ISS) in the extinction curve (Massa et al. 2020). The 3 main features are at 4370, 4870, and 6300 Å. The first two are positively correlated with the 2175 Å bump, which is weak in Orion, but the last one is not. Inverse wavelength is 1.997 to 2.016 μm^{-1} for [O III] and 1.29 to 1.40 for [Ar III]. These are both regions where ISS is increasing with inverse wavelength, which would tend to steepen the extinction curve slightly.

2.3. *Continuum colors*

Broad band colors of the pure continuum can be a diagnostic of scattered light.

We should try and subtract off the atomic continuum.

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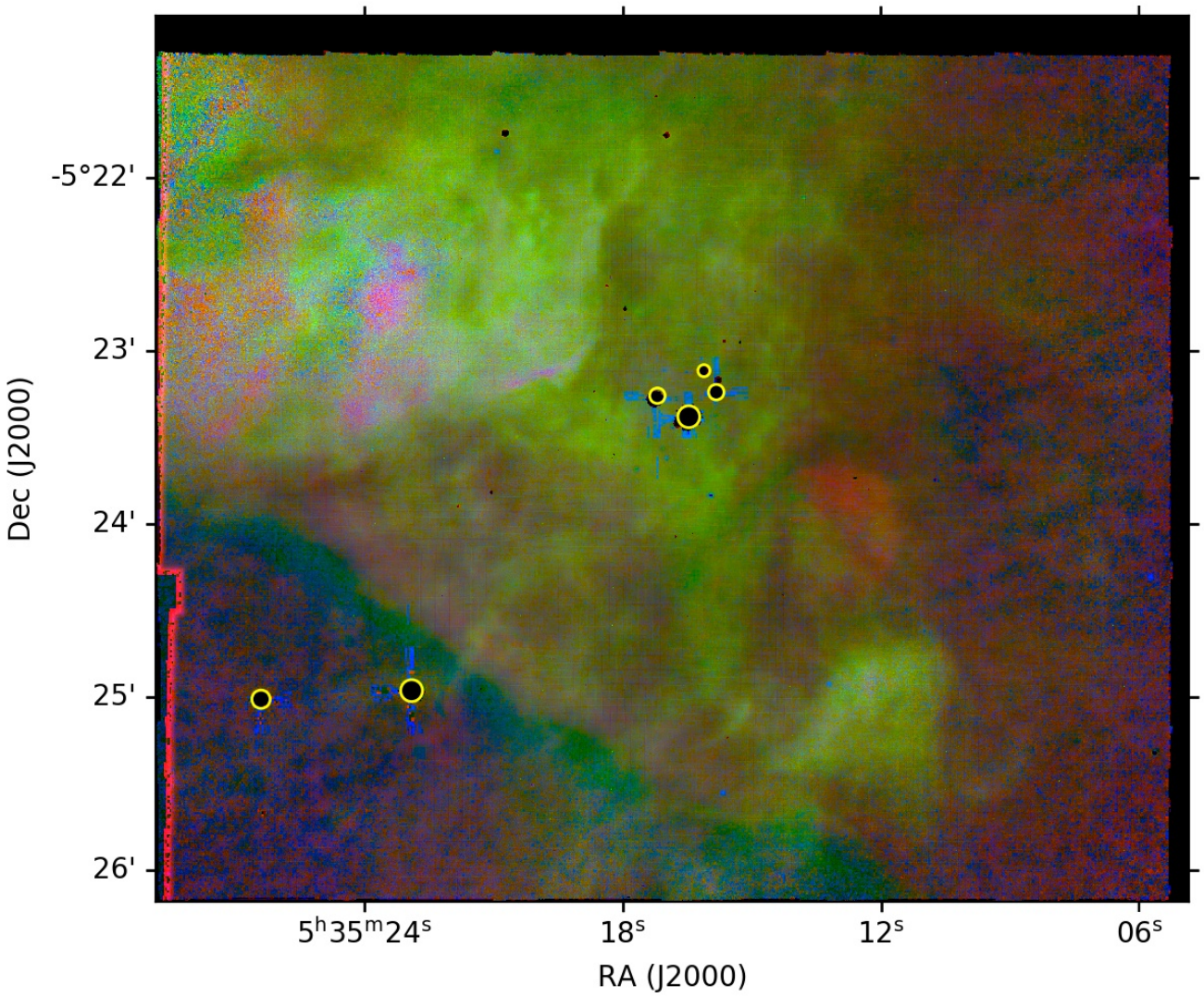

Figure 2. Three-color image of extinction in the inner Orion Nebula. Extinction derived from the optical band reddening of the Balmer decrement (4886 Å to 6563 Å) is shown in green. The infrared/optical extinction anomaly is shown in blue and the radio/infrared extinction anomaly is shown in red.

REFERENCES

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