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Raman mapping of atomic hydrogen in the Orion Bar and Orion South

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Abstract

I show that the broad Raman-scattered wings of Hα can be used to map neutral gas illuminated by high-mass stars in star forming regions. The near wings ($\Delta\lambda \approx \pm 10$ Å) trace neutral columns Absorption features in the pseudo-continuum at 6634 and 6663 Å correspond to neutral oxygen far-ultraviolet absorption lines at 1027.43 Å and 1028.16 Å.

Keywords: Atomic physics; Radiative transfer; Photodissociation regions

1. INTRODUCTION

Dopita et al. (2016) were the first to identify Raman scattering in the Orion Nebula.

Dopita et al. (2016) propose that the Raman wings form at the transition zone near the ionization fronts in H II regions. However, the total neutral hydrogen column through the ionization front can be no more than about $10/\sigma_0$, where $\sigma_0 \approx 6.3 \times 10^{-18}\,\mathrm{cm}^2$. The Raman scattering cross section at wavelengths responsible for the observed wings is much lower than this: $\sigma_{\mathrm{Raman}} \sim 1 \times 10^{-22}\,\mathrm{cm}^2$ (Chang et al. 2015), meaning that the Raman scattering optical depth through the ionization front is only of order 0.0001. A vastly larger column density of neutral hydrogen is available in the photodissociation region outside the ionization front, so it is more likely that Raman scattering will occur there instead, so long as there is sufficient far ultraviolet radiative flux in the vicinity of the Lyman β line (1025 Å).

2. OBSERVATIONS

MUSE (Bacon et al. 2010) observations of the Orion Nebula (Weilbacher et al. 2015; Mc Leod et al. 2015).

3. DISCUSSION

The effective resolving power of the optical spectrograph is multiplied by 6.4 for the FUV domain.

The O I lines should be in absorption in the spectrum seen by the Raman scatterers.

Salgado et al. (2016) had found low dust cross-section in Orion Bar PDR, but there are loopholes. First, they assume plane-parallel geometry with exactly edge-on viewing angle, while in reality it is a roughly cylindrical filament. Second, they ignore scattering, see Watson et al. (1998).

REFERENCES

Bacon, R., Accardo, M., Adjali, L., et al. 2010, in Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, Vol. 7735, Proc. SPIE, 773508, doi: 10.1117/12.856027

Chang, S.-J., Heo, J.-E., Di Mille, F., et al. 2015, ApJ, 814, 98, doi: 10.1088/0004-637X/814/2/98

Dopita, M. A., Nicholls, D. C., Sutherland , R. S., Kewley, L. J., & Groves, B. A. 2016, ApJL, 824, L13, doi: 10.3847/2041-8205/824/1/L13

Mc Leod, A. F., Weilbacher, P. M., Ginsburg, A., et al. 2015, ArXiv e-prints. https://arxiv.org/abs/1511.01914

Salgado, F., Berné, O., Adams, J. D., et al. 2016, ApJ, 830, 118, doi: 10.3847/0004-637X/830/2/118

Watson, A. M., Henney, W. J., & Escalante, V. 1998, in American Astronomical Society Meeting Abstracts, Vol. 193, 16.03

Weilbacher, P. M., Monreal-Ibero, A., Kollatschny, W., et al. 2015, A&A, 582, A114, doi: 10.1051/0004-6361/201526529

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