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On the origins of the diffuse Hα emission: ionized gas or dust-scattered Hα halos?

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Abstract. We find that the dust-scattering origin of the diffuse Hα emission cannot be ruled out. As opposed to the previous contention, the expected dust-scattered Hα halos surrounding H II regions are, in fact, in good agreement with the observed Hα morphology. We calculate an extensive set of photoionization models by varying elemental abundances, ionizing stellar types, and clumpiness of the interstellar medium (ISM) and find that the observed line ratios of [S II]/Hα, [N II]/Hα, and He I λ5876/Hα in the diffuse ISM accord well with the dust-scattered halos around H II regions, which are photoionized by late O- and/or early B-type stars. We also demonstrate that the Hα absorption feature in the underlying continuum from the dust-scattered starlight ("diffuse galactic light") and unresolved stars is able to substantially increase the [S II]/Hα and [N II]/Hα line ratios in the diffuse ISM.

Keywords. ISM: general, HII regions, scattering

It is known that the diffuse Hα emission outside of bright H II regions not only are very extended, but also can occur in distinct patches or filaments far from H II regions, and the line ratios of [S II]/Hα and [N II]/Hα observed far from bright H II regions are generally higher than those in the H II regions. These observations have been regarded as evidence against the dust-scattering origin of the diffuse Hα emission (including other optical lines), and the effect of dust scattering has been neglected in studies on the diffuse Hα emission. In this talk, we demonstrate that the basic morphological properties of the diffuse H emission can be explained well by the dust-scattered halo surrounding the H II nebula, as opposed to the previous belief that dust scattering does not accord with the H and R-band observations. We show that the optical line ratios of He I/Hα, [N II]/Hα, and [S II]/Hα observed in the diffuse ISM outside of bright H II regions can be reproduced well by the dust-scattered halo scenario, wherein the optical lines originate from H II regions ionized by late O- or early B-type stars in the media with abundances close to WNM and are scattered off by the interstellar dust. The predicted [N II]/Hα and [S II]/Hα line ratios increase with the clumpiness of ISM.

We find that the surface brightness of the individual dust-scattered halos can be approximated well by a formula used by Zurita *. et al.* (2002) and Seon (2009). These results seem to strongly suggest the dust-scattering origin of the diffuse Hα emission in the face-on galaxies. We also show that the Balmer absorption lines in the underlying stellar continuum seem to explain the rise of line ratios in the faint Hα regions. We may need to develop more realistic models of the global Hα morphologies of face-on galaxies in the contexts of not only dust scattering, but also photoionization.

References

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