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DUSTY OUTFLOWS IN NARROW-LINE REGIONS

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When spectra of the narrow-line regions (NLR) of Seyfert Galaxies are examined, the emission-line ratios show a remarkable similarity, which is hard to understand with current models. What makes this similarity so remarkable is that it holds even over large distance and kinematical scales. In fact, recent observations show NLR outflows reaching 3000 km s^{-1} in a typical Seyfert 2, NGC 1068. Here, we put forward a new model of the physical conditions in the NLR, which may explain both the similarity in line emission and these amazing outflows: radiation pressure dominated, dusty, photoablating clouds.

1. DUST AND RADIATION PRESSURE

The emission lines of Seyfert 2 galaxies show a remarkable similarity, with line ratios from different galaxies all lying within ~ 0.5 dex of each other. The standard models of narrow-line regions (NLR) cannot explain this without the introduction of several, poorly constrained, free parameters. Here, we propose a plausible model of the physical structure with dusty, radiation pressure dominated, photoionized clouds, which can explain this strange observation.

There is a critical value of the ionization parameter U above which dust absorption dominates over photoelectric absorption, which is easily estimated to be $U \sim 0.007$. This value is also closely related to that at which radiation pressure begins to dominate the gas pressure or dynamical acceleration of the plasma. This means that for ionization parameters above the critical value, the gas pressure close to the ionization front is determined by the externally imposed ionization parameter, U. Thus, an increase in U leads to a corresponding increase in the density near the front such that the local ionization parameter becomes independent of U. In this way, the lower ionization lines will become independent of the external ionization parameter.

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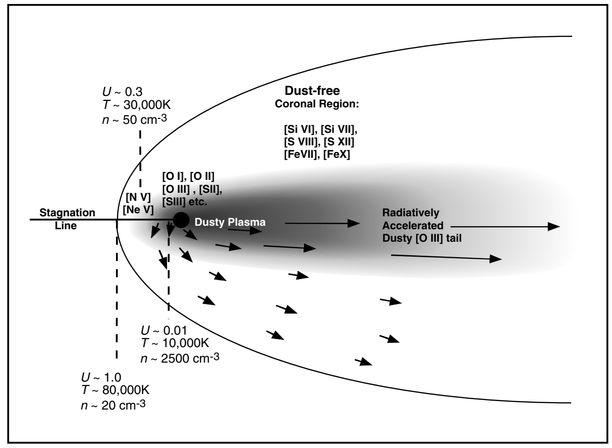

Fig. 1. Depiction of our theoretical model showing the dusty photoablated cloud with accelerated [O III] tail (Dopita et al. 2002).

2. DUSTY OUTFLOWS

This simplified picture only strictly applies along the stagnation line of the photoionized cloud. Around the cloud edges, the radiation pressure force acts radially outward from the ionizing source, driving an accelerating flow outwards from the Active Galactic Nucleus (AGN) (such a scenario is shown in Figure 1, our model depiction of a NLR cloud).

Evidence for such outflows is seen in the nearby Seyfert 2, NGC 1068. Recent *HST* STIS observations of NGC 1068 in [O III] (Cecil et al. 2002) show NLR clouds ~ 100 pc from the nucleus with comet-like tails which have been accelerated beyond 2000 km s^{-1} over distances of around $0\farcs15$ (10 pc).

Thus, we propose that the NLR of Seyfert galaxies can be self-consistently modeled by dusty, radiation pressure dominated, photoablating clouds. This model can not only provide a line spectrum that is invariant against changes in external ionization parameter over a large range, but it may also offer an explanation for the high-velocity structures seen in the NLR clouds with the strong radial acceleration of dusty gas due to radiation pressure.

REFERENCES

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