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KINEMATICS FROM SPECTRAL LINES FOR AGN OUTFLOWS BASED ON TIME-INDEPENDENT RADIATION-DRIVEN WIND THEORY

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RESUMEN

Construimos un modelo de fotoionización dependiente de la velocidad para el absorbedor tibio de NGC 3783. Adoptando formas funcionales de la velocidad del flujo y su densidad del número de partículas con el radio, apropiadas para un viento acelerado por radiación, calculamos el nivel de ionización, la temperatura, el corrimiento Doppler y las profundidades ópticas de las líneas como función de la distancia. El modelo reproduce la relación observada entre la ionización del gas y el corrimiento del centroide de las líneas de absorción en NGC 3783. Este espectro requiere de la presencia de dos flujos: uno altamente ionizado responsable de las alas azules de las líneas de alto grado de ionización y al mismo tiempo las alas rojas de las líneas de menor grado de ionización; y uno de baja ionización que produce las alas azules de las líneas de oxígeno.

ABSTRACT

We build a bulk velocity-dependent photoionization model of the warm absorber of the Seyfert 1 galaxy NGC 3783. By adopting functional forms for the velocity of the flow and its particle density with radius, appropriate for radiation-driven winds, we compute the ionization, the temperature, the line Doppler shift, and the line optical depths as a function of distance. The model reproduces the observed relationship between the gas ionization and the velocity shift of the absorption line centroids in the X-ray spectrum of NGC 3783. The distribution of asymmetry seen in this spectrum requires the presence of two outflows: a higher ionization component responsible for the blue wings of the high ionization lines and the red wings of the low ionization oxygen lines, and a lower ionization flow that produces the blue wings of the oxygen lines.

Key Words: galaxies: Seyfert — quasars: absorption lines — quasars: individual (NGC 3783)

1. INTRODUCTION

X-ray (0.5–10 keV) *Chandra* spectra of type-I active galactic nuclei (AGN) often show the presence of absorption lines coming from H- and He-like ions of O, Ne, Mg, Si, S as well as from Fe XVII-Fe XXIII L-shell transitions. These lines are near the region of the bound-free absorption edges of O VII and O VIII at ∼0.8 keV, which are the hallmark of warm absorbers (George et al. 1998; Komossa 1999). In Seyfert 1 galaxies these absorption lines can be narrow (Seyfert 1 NALs) with full width at half maximum (FWHM) spanning ∼100–500 km s^{-1} (Kaspi et al. 2000), or broad (Seyfert 1 BALs) with FWHM ∼500–2000 km s^{-1} (Kaspi et al. 2001). The troughs of the lines are blue-shifted relative to rest frame of the host galaxy with velocities that go from several hundred to a few thousand km s^{-1} (Yaqoob et al. 2003), implying the presence of outflows that cover a wide range of velocities and ionization stages (Kaastra et al. 2000; Kaspi et al. 2002; Krolik & Kriss 2001; Różańska et al. 2006).

In Seyfert galaxies and quasars, absorption spectra show a range of ionization stages that arise from ionization parameters that span ξ∼10–1000 erg cm s^{-1} (Kaspi et al. 2002). Simultaneous UV and X-ray observations may enhance this range