Astrophysics in the Far Ultraviolet, Five Years of Discovery with FUSE
ASP Conference Series, Vol. 348, 2006
Sonneborn, Moos & Andersson

Gaseous Outflows in Seyferts and Unification

P. Shastri

Indian Institute of Astrophysics, Bangalore 560034, India

J. Hutchings

NRC Herzberg Institute of Astrophysics, Victoria BC V9E 2E7, Canada

J. Murthy

Indian Institute of Astrophysics, Bangalore 560034, India

B.J. Wills

Astronomy Dept., University of Texas, Austin, TX 78712, USA

Abstract. We present our results from *FUSE* observations of Seyfert galaxies of type 2 (Sy 2). We attempt to contrast the properties of the emission lines and absorbing outflows in Sy 1s and 2s in the framework of Unification. We find that the O VI emission in Sy 2s is narrow as predicted. We also find evidence for absorption, and blue-ward asymmetry of the O VI line profile.

1. Introduction

Seyfert galaxies are the nearby, low-luminosity subclass of radio-quiet active galaxies that typically inhabit spiral hosts. They show synchrotron-emitting collimated jets on the scale of $\sim$ 1kpc, as well as evidence for energetic winds as seen in the many spectacular results from *FUSE* and *CHANDRA* (*e.g.*, Kriss, these proceedings); the winds show intrinsic absorption, often occuring together with warm absorption in X-rays, sometimes variable, and in multiple components, all of which implies complex kinematics. Here we attempt to contrast the properties of outflows from Seyfert (Sy) nuclei of the purportedly pole-on and edge-on kinds, *i.e.*, Sy 1 and 2s, as manifested in the emission and absorption lines in the Far-UV.

Seyfert 1s are those with clear, spectrophotometrically detectable permitted lines in the visible which are broader than their forbidden lines, whereas those of type 2 have permitted and forbidden lines of similar widths. Seyfert Unification hypothesizes that due to a ubiquitous optically thick torus around the nucleus, a Seyfert 1 appears like a Seyfert 2 when viewed edge-on Antonucci (1993). Most of the Seyfert galaxies that have been observed with *FUSE* (*e.g.*, Kriss, these proceedings) are of type 1. We have observed three Seyfert 2 galaxies with *FUSE*, two of which show the O VI emission doublet, and in one of which (Mrk 533) we detect the O VI and C III λ977 emission lines. Mrk 533 is known to have a central hidden Broad Emission Line Region detected periscopically via spectropolarimetry (Tran 1995).

2. The *FUSE* Observations and Reductions

The LWRS aperture was used for the observations made in TTAG mode. Mrk 533 had data from two exposures of $\sim$ 10ksec each, separated by two days. Since our data

indicated that the background had been oversubtracted, by *CALFUSE*, we instead implemented a subtraction procedure using neighbourhood pixels next to the aperture. We used a binning factor of 32 for this purpose. After averaging the pixels in the cross-dispersion direction, a median filtering in the dispersion direction was performed in order to obtain the background. Although the wavelength-dependence of the background is thereby smoothed, we believe that the background thus obtained is more representative.

3. Results

The spectra of Mrk 533 from the two LiF detectors reveal the O VI doublet at the expected redshift (Fig. 1). The line is *narrow*, *i.e.*, FWHM$<$ 1000 $km\ s^{-1}$, in predicted contrast to purportedly pole-on Seyferts (Sy 1s), where the FWHM$>$ 1000 $km\ s^{-1}$, with an additional narrow component in some cases (Kriss, these proceedings).

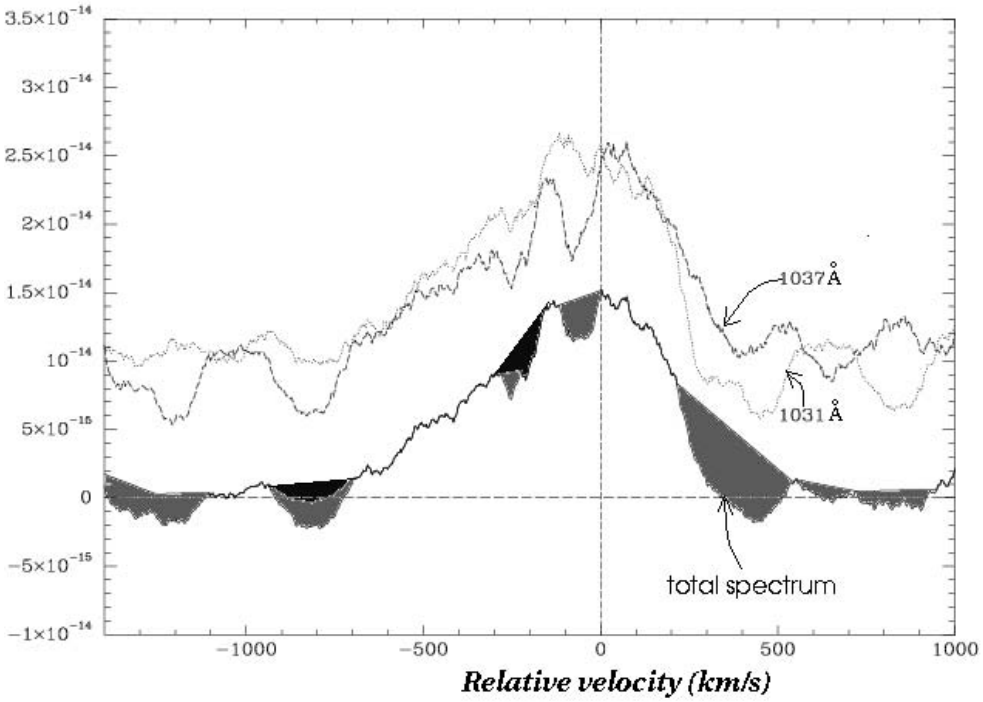

Figure 1. The spectrum in the redshifted O VI doublet region of Mrk 533 from LiF1A & LiF2B, in velocity space. The grey dips are those ascribed to absorption by Galactic H_2, and those shaded black are intrinsic to Mrk 533.

As expected, Galactic H_2 produces contaminating absorption features, and some of the dips in the spectrum of Mrk 533 can be consistently accounted for by the stronger dips in the Galactic H_2 model spectrum. There remain residual dips, however, at -200 and $-800\ km\ s^{-1}$ relative to systemic which we ascribe to absorption intrinisic to Mrk 533. The spectrum in the redshifted C III λ977 region (Fig. 2) shows that although the S/N is low, there is a dip in both the LiF1A and the LiF2B data in a region clear of Galactic H_2 absorption, which is probably intrinsic to Mrk 533. It occurs at the same relative velocity as one of the intrinisic absorption troughs in the O VI line profile.

The O VI profile shows a blue wing, similar to the [O III] λ5007 line. From the *STIS* data in the [O III] λ5007 region (Whittle, priv. comm.) it is clear that the blue wing

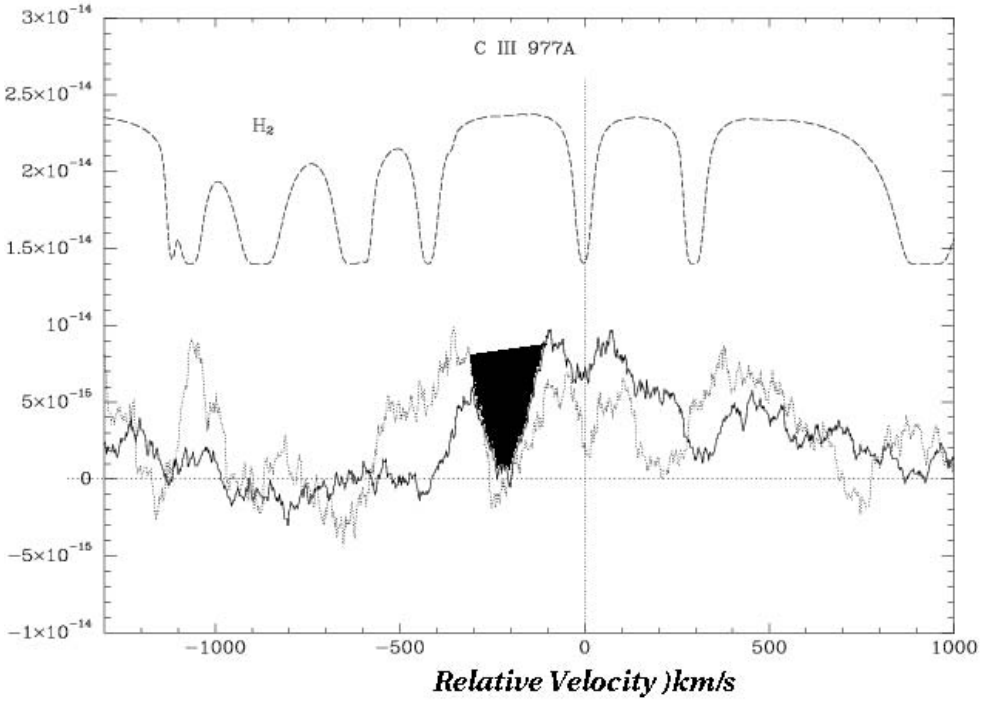

Figure 2. The redshifted C III region of Mrk 533: data from the LiF1A & LiF2B detectors (bottom), and the model Galactic H_2 absorption spectrum (top) in velocity space. The trough shaded black at $-200\ km\ s^{-1}$ appears in both detectors in a region with no expected Galactic H_2 absorption.

is from an approaching outflow. The profile of the O VI line is not as asymmetric as that of the O III λ5007 line (Veilleux 1991), however, contrary to the correlation of asymmetry index with ionization potential for Mrk 533 (de Robertis and Shaw 1990).

Acknowledgments. Help from the *FUSE* team, discussions with Suzy Collin, and *STIS* data of Mark Whittle are all gratefully acknowledged. This research has made use of NASA's ADS bibliographic services and the NASA/IPAC Extragalactic Database (NED) which is operated by JPL, CalTech, under contract with NASA.

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