Punsly Brian

Position: Research Scientist
Period covered: 2010

I. Scientific Work

Brian Punsly/ICRANet Research 2009 and 2010

ABSTRACT:
This report describes the research performed by Brian Punsly in cooperation with ICRANet in 2010.
1. Introduction
In 2010, the research was concentrated in three areas. First, I discovered a propensity for red (redward of the QSO systemic velocity) broad line emission excess in radio loud quasars that is accentuated for polar lines of sight. Second my discovery working with Shaohua Zhang of excess narrow line widths of broad emission lines in broad absorption line quasars and showing that this is best explained by polar lines of sight. I am also leading collaborations to perform high frequency (high resolution), time resolved VLBA observations of broad absorption line quasars.

2. The Redshifted Excess in Quasar C IV Broad Emission Lines
The article, The Redshifted Excess in Quasar C IV Broad Emission Lines" was written for ApJ 2010. 713, 232 with the intention of trying to determine a unique signature of the accretion environment of radio loud AGN that could help discriminate between the wide range of boundary conditions that are assumed in simulations of black hole magnetospheres.
ABSTRACT: In this article, the Evans and Koratkar Atlas of Hubble Space Telescope Faint Object Spectrograph Spectra of Active Galactic Nuclei and Quasars is used to study the redward asymmetry in CIV broad emission lines (BELs). It is concluded that there is a highly significant correlation between the spectral index from 10 GHz to 1350 Angstroms and the amount of excess luminosity in the red wing of the CIV BEL (> 99:9999% significance level for the full sample and the radio loud subsample independently, but no correlation is found for the radio quiet subsample). This is interpreted as a correlation between radio core dominance and the strength of the CIV redward asymmetry. The data implies that within the quasar environment there is BEL gas with moderately blueshifted emission associated with the purely radio quiet quasar phenomenon (the accretion disk) and the radio jet emission mechanism is associated with a redward BEL component that is most prominent for lines of sight along the jet axis. Thus, radio quiet quasars have CIV BELs that tend to show blueshifted excess and radio loud quasars show either a red or blue excess with the tendency for a dominant red excess increasing as the line of sight approaches the jet axis.
As a follow-on to this work, we obtained a third epoch of observation of one of the most redward asymmetric gamma ray superluminal gamma ray blazars, 0954+556, with the Lick 3 meter telescope with Matt Malkan of UCLA. In the optical the Mg II line is visible and a sample figure is shown below.

3. Hβ Line Widths as an Orientation Indicator for Broad Absorption Line Quasars
The article, "Hβ Line Widths as an Orientation Indicator for Broad Absorption Line Quasars" was written for ApJ with Shaohua Zhang from Key Laboratory for Research in Galaxies and Cosmology, University of Sciences and Technology of China, China Academy of Science, Hefei, Anhui, 230026, China. The article is in press for ApJ. This is part of a multi-tiered study trying to understanding why some quasars have radio jets and others the outflow is dominated by a broad absorption line wind.
ABSRACT: There is evidence from radio-loud quasars to suggest that the distribution of the Hβ broad emission line (BEL) gas is arranged in a predominantly planar orientation, and this result may well also apply to radio-quiet quasars. This would imply that the observed full width at half maximum (FWHM) of the Hβ BELs is dependent on the orientation of the line of sight to the gas. If this view is correct then we propose that the

FWHM can be used as a surrogate, in large samples, to determine the line of sight to the Hβ BELs in broad absorption line quasars (BALQSOs). The existence of broad UV absorption lines (BALs) means that the line of sight to BALQSOs must also pass through the BAL out-flowing gas. It is determined that there is a statistically significant excess of narrow line profiles in the SDSS DR7 archival spectra of low ionization broad absorption line quasars (LoBALQSOs), indicating that BAL gas flowing close to the equatorial plane does not commonly occur in these sources. We also find that the data is not well represented by random lines of sight to the BAL gas. Our best fit indicates two classes of LoBALQSOs, the majority (≈ 2/3) are polar outflows, that are responsible for the enhanced frequency of narrow line profiles, and the remainder are equatorial outflows. We further motivated the line of sight explanation of the narrow line excess in LoBALQSOs by considering the notion that the skewed distribution of line profiles is driven by an elevated Eddington ratio in BALQSOs. We constructed a variety of control samples comprised of nonLoBALQSOs matched to a de-reddened LoBALQSO sample in redshift, luminosity, black hole mass and Eddington ratio. It is demonstrated that the excess of narrow profiles persists within the LoBALQSO sample relative to each of the control samples with no reduction of the statistical significance. Thus, we eliminate the possibility that the excess narrow lines seen in the LoBALQSOs arise from an enhanced Eddington ratio.
In pursuit of more information one can also investigate the far more numerous high ionization BALQSOs. In order for a HiBALQSO to be detected from an earth based telescope requires that C IV be visible through the earth's atmosphere, i.e. z > 1.5. Thus, Hβ lies beyond the optical band in the IR. There are bands in the IR where Hβ is still visible at the appropriate redshift. I have submitted a proposal to use the ISAAC spectrograph at the ESO VLT to obtain a modest sample (40) of J and H band spectra of Hβ of HiBALQSOs with Paola Marziani, INAF, Osservatorio Astronomico di Padova, Vicolo dell' Osservatorio 5, IT 35122, Padova, Italy and Jack Sulentic, Instituto de Astrof´ısica de Andaluc´ıa (CSIC), C/ Camino Bajo de Hu´etor 50, 18008 Granada, Spain.

4. VLBA Observations of Sub-Parsec Structure in Mrk 231: Interaction between a Relativistic Jet and a BAL Wind

I am leading an effort to study Mrk 231 at the highest resolution. It is the nearest broad absorption line quasar and we have proven that it conforms with the idea of a polar broad absorption line outflow (instead of the popular notion of an equatorial outflow) that was developed in Punsly (1999a,b). This research and proposal is being done in collaboration with Cormac Reynolds (Curtin University of Technology, Department of Imaging and Applied Physics), Christopher P. O'Dea (Department of Physics, Rochester Institute of Technology) and Joan Wrobel (NRAO, Socorro).

4.1. Large VLBA Proposal Approved

We have already received re-approval for 2010/2011 for a very aggressive observation this object.

4.1.1. Abstract

We propose VLBA monitoring at 8.4, 15, 22 and 43 GHz of a high frequency flare in the nearby quasar MRK231. The "target of opportunity" observation (ToO) would be triggered by a flare detected by VLA monitoring at 22 and 43 GHz (see related proposal). The primary goals would be to detect a superluminal motion, estimate the internal energy of the flare from the spectrum and component sizes, and monitor the temporal evolution in order to understand the energy injection mechanism (rise) and the cooling mechanism (decay).

4.1.2. Background

From previous VLBA studies of MRK231 in Reynolds et al (2009) and other RQ (radio quiet) quasar studies, we have seen that RQ AGN can have relativistic outflows with significant kinetic luminosities (but maybe for short periods of time). So this raises the question what is it that makes some sources RQ and others radio loud (RL)? At a redshift of 0.042, MRK231 is one of the nearest radio quiet quasars to earth. The radio core is perhaps the brightest of any radio quiet quasar at high frequency (22 and 43 GHz). The combination of significant 43 GHz flux density and its proximity to earth makes MRK231 the optimal radio quiet quasar for study with VLBA. No other radio quiet quasar central engine can be explored with such high resolution, so it is ideal for studying the high kinetic luminosity relativistic ejecta in radio quiet quasars. 43 GHz VLBA observations can fully resolve nuclear structure to within 3.5 x 1017 cm. We propose to use sensitive high resolution observations to study the temporal evolution of the size and spectrum of a strong flare in MRK231 in order to shed light on why such strong flares cool off and never link to large scale powerful radio lobes.

5. VLBA Observations of Parsec Scale Structure of the "Radio Loud" BALQSO FIRST J1556+3517

I am also leading an effort to study FIRST J1556+3517at the high resolution. It is one of the nearest broad absorption line quasar and we have proven (Ghosh and Punsly 2007) that it conforms with the idea of a polar broad absorption line outflow (instead of the popular notion of an equatorial outflow) that was developed in Punsly (1999a,b). This accepted proposal was done in collaboration with Cormac Reynolds (Curtin University of Technology, Department of Imaging and Applied Physics), and Christopher P. O'Dea (Department of Physics, Rochester Institute of Technology).

ABSTRACT FROM ACCEPTED PROPOSAL: We propose VLBA observations at 1.8, 5, 8.4 and 15 GHz of the Broad Absorption Line Quasar FIRST J1556+3517 ("the first radio loud BALQSO"). The primary goal would be to resolve the flat spectrum radio core for the first time. Determination of the radio jet direction, in consort with the knowledge that the jet is relativistic and viewed in a pole-on orientation and the known PA of the optical continuum polarization tightly restrict the quasar geometry. This will allow us to directly constrain the relative orientations of the "dusty torus" (scattering surface), accretion disk and the broad absorption line outflow. We also propose multiple frequency observations to look for free-free absorption that might arise from the local environment of the accretion disk or the BAL wind gas itself. If the jet is resolved by the VLBA, this observation would be the first data point in a search for component motion. If the jet is not resolved, the incredibly compact nature of the relativistic outflow indicates a severe kinematical environment.

REFERENCES

Ghosh, K. and Punsly, B. 2007 ApJL 661 139
Punsly, B. 1999, ApJ 527 609
Punsly, B. 1999, ApJ 527 624

RELATED 2010 PUBLICATIONS:

Punsly, B. 2010, ApJ 713 232
Punsly, B. and Zhang, S. 2010, ApJ in press