Brian Punsly

Position: Research Scientist
Period covered: 12/2019-12/2020

I Scientific Work

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Black Holes and Quasars

1. Introduction

This report describes the research performed by Brian Punsly and collaborators in cooperation with ICRANet in 2020. The research was directed at finding environmental factors that are related to the switch-on of the general relativistic engine responsible for the few percent of accreting black holesthat drive powerful relativistic jets. This is important since this will relate directly to constraints on the initial state and boundary conditions on numerical models of black hole driven jets.

2. **The Energetics of Launching the Most Powerful Jets in Quasars: A Study of 3C 82**

Abstract:
3C□82□at□a□redshift□of□2.87□is□the□most□distant□3C□(Third□Cambridge□Catalogue)□quasar.□Thus,□it□is□a□strong□candidate□to□have□the□most-luminous□radio□lobes□in□the□universe.□3C□82□belongs□to□the□class□of□compact□steep-spectrum□radio□sources.□We□use□single-dish□and□interferometric□radio□observations□in□order□to□model□the□plasma□state□of□these□powerful□radio□lobes.□It□is□estimated□that□the□long-term□time-averaged□jet□power□required□to□fill□these□lobes□with□leptonic□plasma□is□$\bar{Q} \approx 2.66 \pm 1.33 \times 10^{47}\,\mathrm{erg\ s^{-1}}$,□among□the□largest□time-averaged□jet□powers□from□a□quasar.□Positing□protonic□lobes□is□not□tenable□as□they□would□require□two□orders□of□magnitude□more□mass□transport□to□the□lobes□than□was□accreted□to□the□central□black□hole□during□their□formation.□The□first□high□signal-to-noise□optical□spectroscopic□observation□obtained□of□this□object□indicates□that□there□is□a□powerful□high-ionization□broad-line□wind□with□a□kinetic□power□of□~10^{45}□erg□s^{-1}□and□a□velocity□of□~$0.01c$.□We□also□estimate□from□the□broad□lines□in□2018□and□the□UV□continuum□in□three□epochs□spread□out□over□three□decades□that□the□accretion□flow□bolometric□luminosity□is□$L_{\rm bol}$□≈□3.2□5.8□□10^{46}□erg□s^{-1}.□The□ratio□of□$\bar{Q}/L_{\rm bol} \approx 5.91 \pm 3.41$ is□perhaps□the□largest□of□any□known□quasar.□Extremely□powerful□jets□tend□to□strongly□suppress□powerful□winds□of□ionized□baryonic□matter.□Consequently,□3C□82□provides□a□unique□laboratory□for□studying□the□dynamical□limits□of□the□central□engine□of□outflow□initiation□in□quasars.

3. **The Extreme Red Excess in Blazar Ultraviolet Broad Emission Lines**

ABSTRACT:

We present a study of quasars with very redward asymmetric (RA) ultraviolet (UV) broad emission lines (BELs). An excess of redshifted emission has been previously shown to occur in the BELs of radio-loud quasars and is most extreme in certain blazars. Paradoxically, blazars are objects that are characterized by a highly relativistic blueshifted outflow toward Earth. We show that the red emitting gas resides in a very broad component (VBC) that is typical of Population B quasars that are defined by a wide Hβ BEL profile. Empirically, we find that RA BEL blazars have both low Eddington rates ($\lesssim$1%) and an inordinately large (order unity) ratio of long-term time-averaged jet power to accretion luminosity. The latter circumstance has been previously shown to be associated with a depressed extreme UV ionizing continuum. Both properties conspire to produce a low flux of ionizing photons, two orders of magnitude less than typical Population B quasars. We use CLOUDY models to demonstrate that a weak ionizing flux is required for gas near the central black hole to be optimally ionized to radiate BELs with high efficiency (most quasars overionize nearby gas, resulting in low radiative efficiency). The large gravitational redshift and transverse Doppler shift result in a VBC that is redshifted by ~2000–5000 km s^{-1} with a correspondingly large line width. The RA BELs result from an enhanced efficiency (relative to typical Population B quasars) to produce a luminous, redshifted VBC near the central black hole.

2020 List of Publication

Punsly, Brian; Hill, Gary J.; Marziani, Paola; Kharb, Preeti; Berton, Marco; Crepaldi, Luca; Indahl, Briana L.; Zeimann, Greg,“The Energetics of Launching the Most Powerful Jets in Quasars: A Study of 3C 82”,2020 ApJ 189 169

Punsly, B., Paola Marziani, Marco Berton, Preeti Kharb, “The Extreme Red Excess in Blazar Ultraviolet Broad Emission Lines”,2020 ApJ903 44