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The Unique, Optically-Dominated Quasar Jet of PKS 1421-490

J.M. Gelbord & H.L. Marshall (MIT)

D.M. Worrall & M. Birkinshaw (U. Bristol)

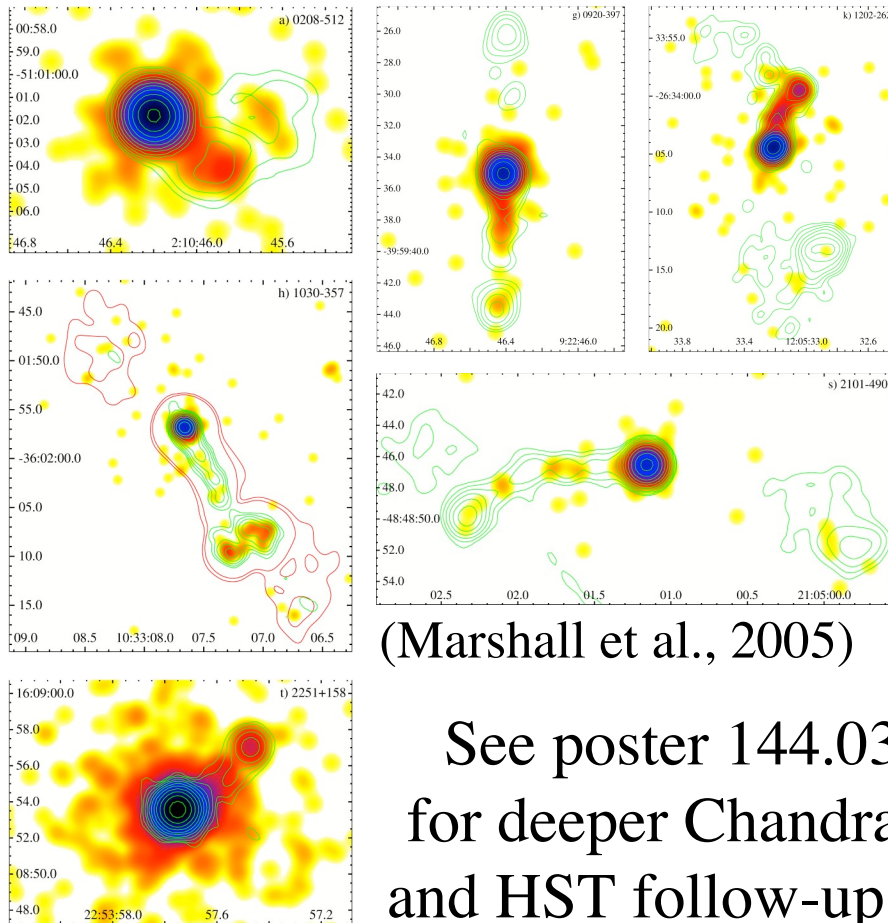
J.E.J. Lovell, R. Ojha, L. Godfrey & D.L. Jauncey (CSIRO)

D.A. Schwartz (SAO)

E.S. Perlman & M. Georganopoulos (UMBC)

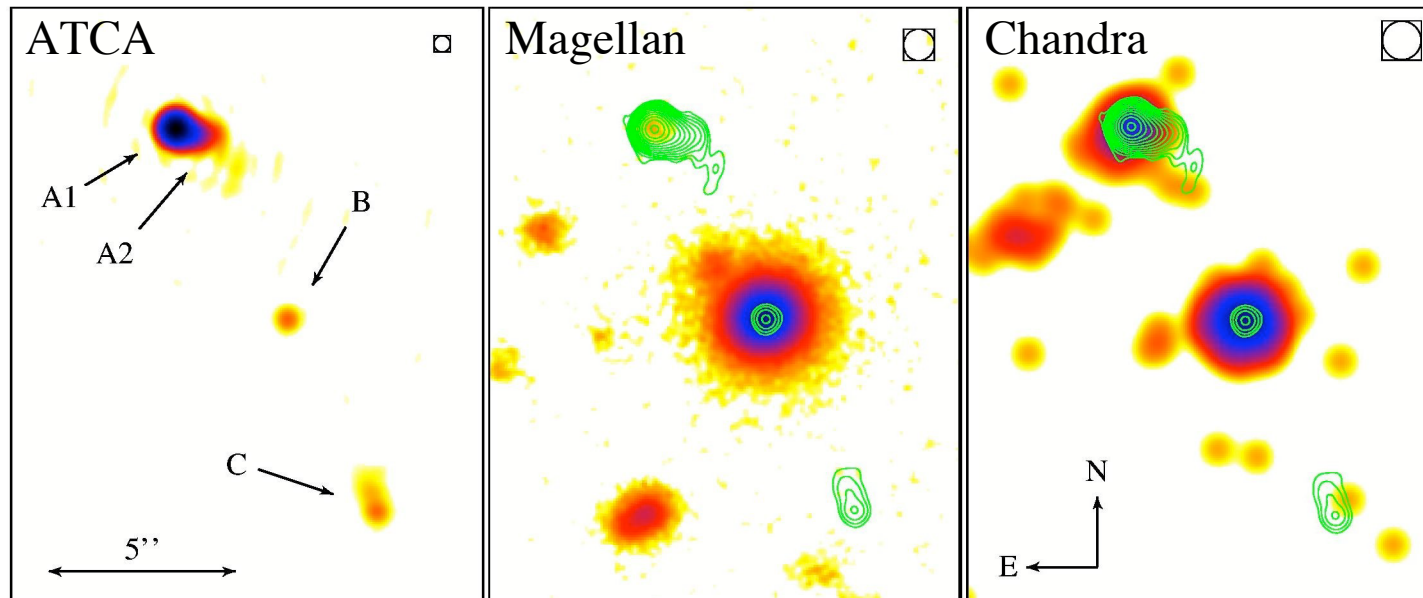
D.W. Murphy (JPL)

The Unique, Optically-Dominated Quasar Jet of PKS 1421-490



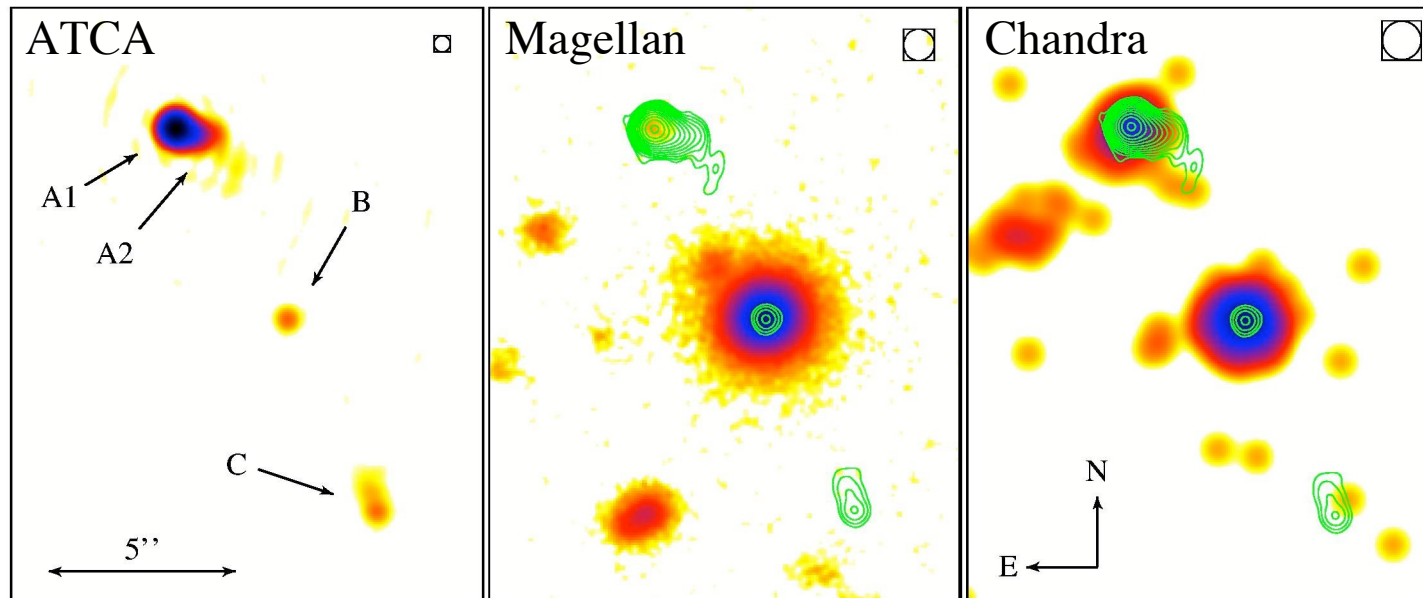
- Ongoing X-ray, optical & radio survey of a large sample of quasar jets
- Results on first 20 just published (Marshall et al. 2005, ApJS 156, 13)
- Ten more observed with Chandra this past year
- Deeper follow-up observations of selected targets are underway

PKS 1421-490 observations



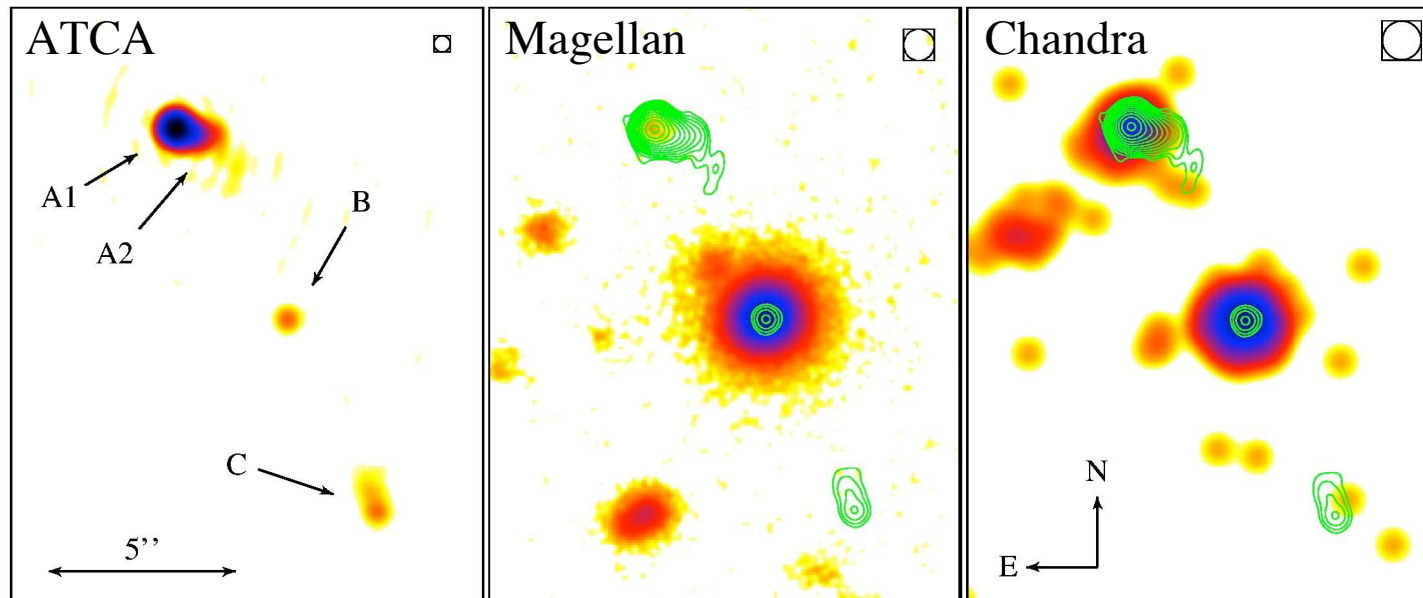
- 20 GHz radio map shows structure:
 - Strongest component is unresolved (A1) with a $\sim 1''$ extension (A2)
 - Component B lies $6''$ SW of A; it may be slightly extended
 - Component C is $12''$ SW of A; it is clearly extended

PKS 1421-490 observations



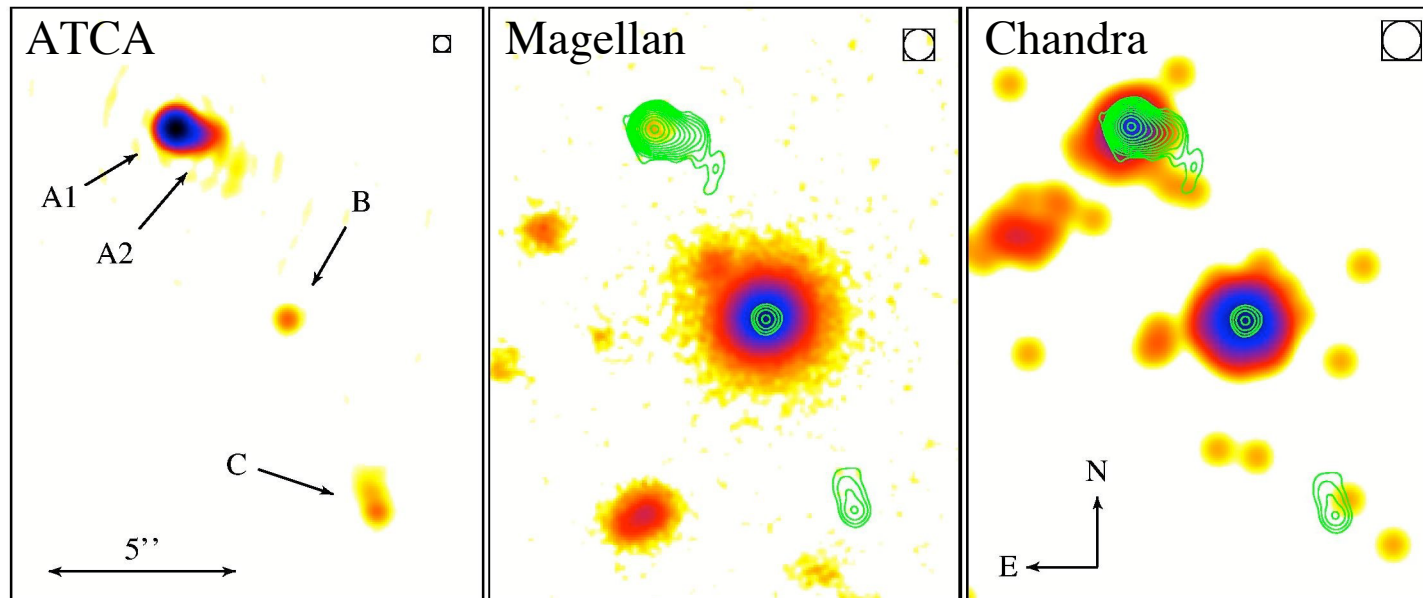
- Optical image (SDSS i' filter):
 - A ($i' = 23$) and B ($i' = 17$) are both detected; unresolved
 - B/A flux ratio is ~ 300
 - C is undetected

PKS 1421-490 observations



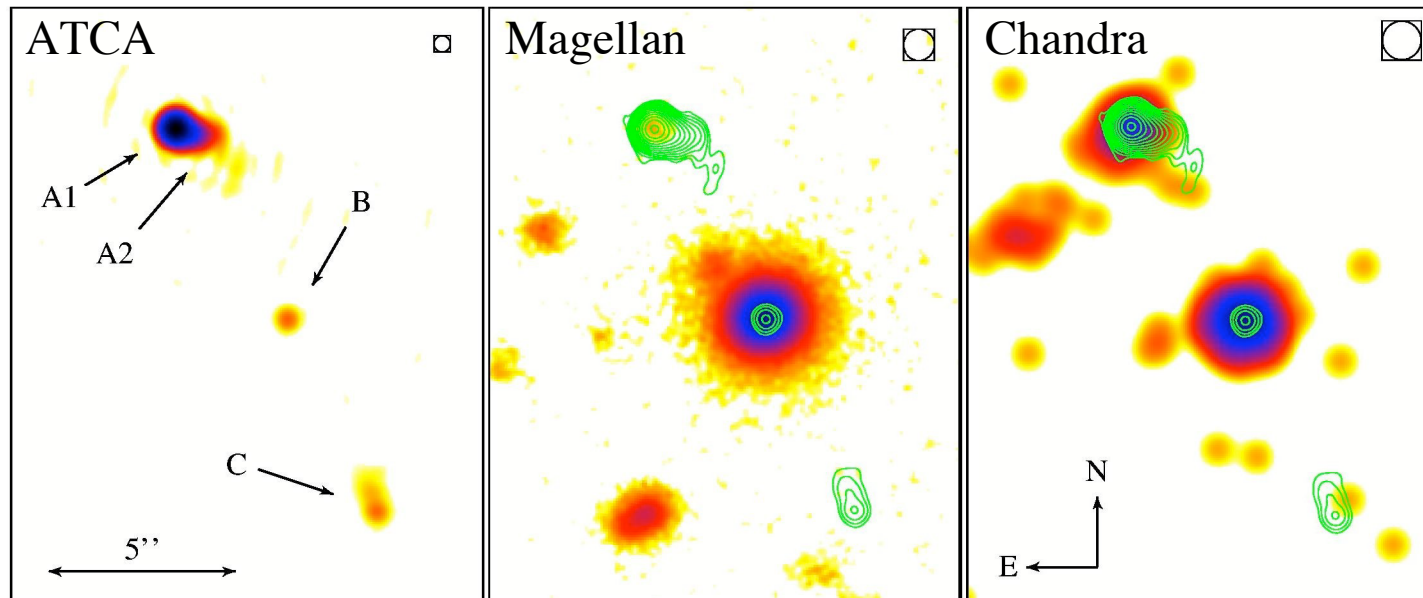
- 0.5-7.0 keV X-ray image:
 - A and B are both detected; unresolved
 - B/A flux ratio is 3.7
 - C is undetected

PKS 1421-490 observations



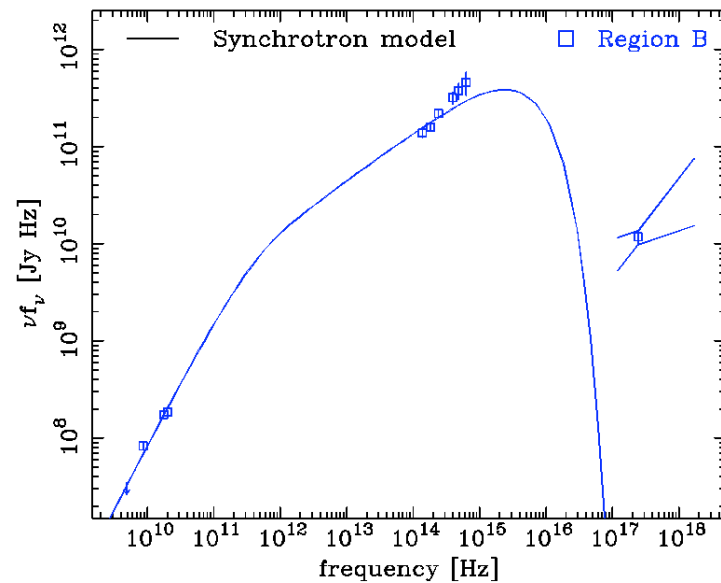
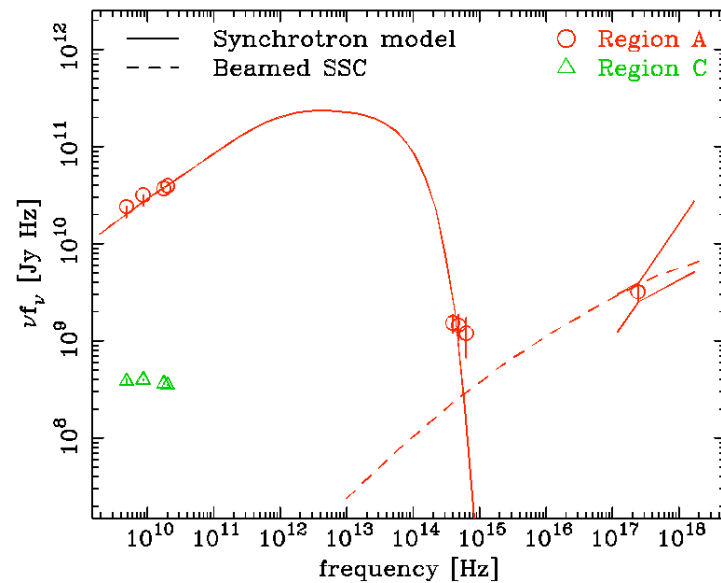
- We interpret this as a one-sided core-jet system:
 - core at A1
 - jet through A2
 - jet knot at B - a very unusual knot...
 - terminal hot spot at C

PKS 1421-490 observations



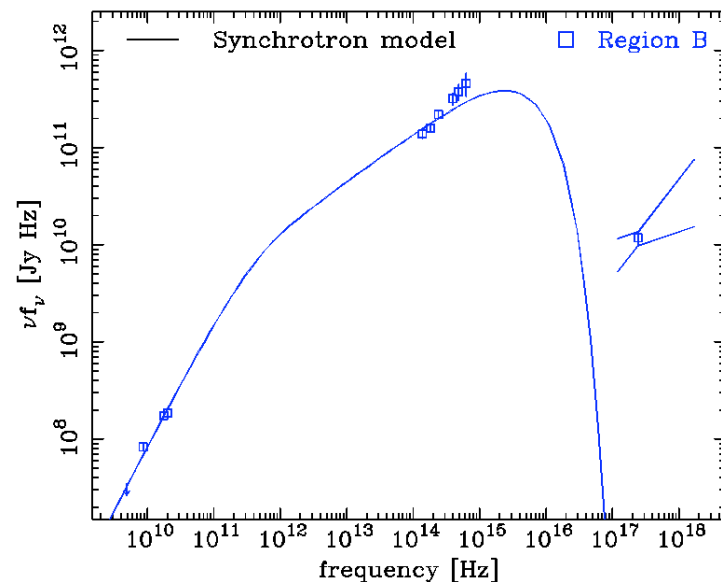
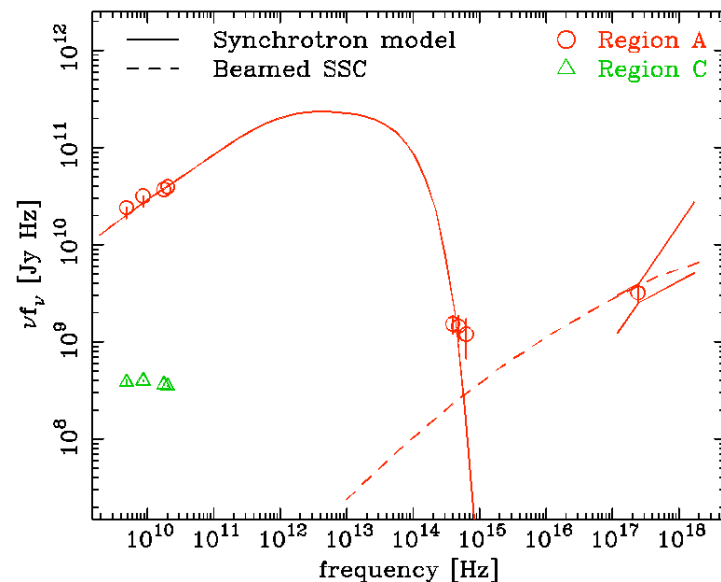
- Alternative (disfavored) interpretations:
 - symmetric system with (atypical) core at B and (unusual) hotspot at A
 - B is unrelated to A and C
 - Featureless optical spectrum rules out stars, normal galaxies, most AGN
 - Not a white dwarf
 - Conceivably a BL Lac, but unlikely and properties would be a new extreme

The enigmatic knot B



- SED of A is typical of cores
- SED of C is steeper, typical of terminal hot spots
- SED of B is puzzling

The enigmatic knot B



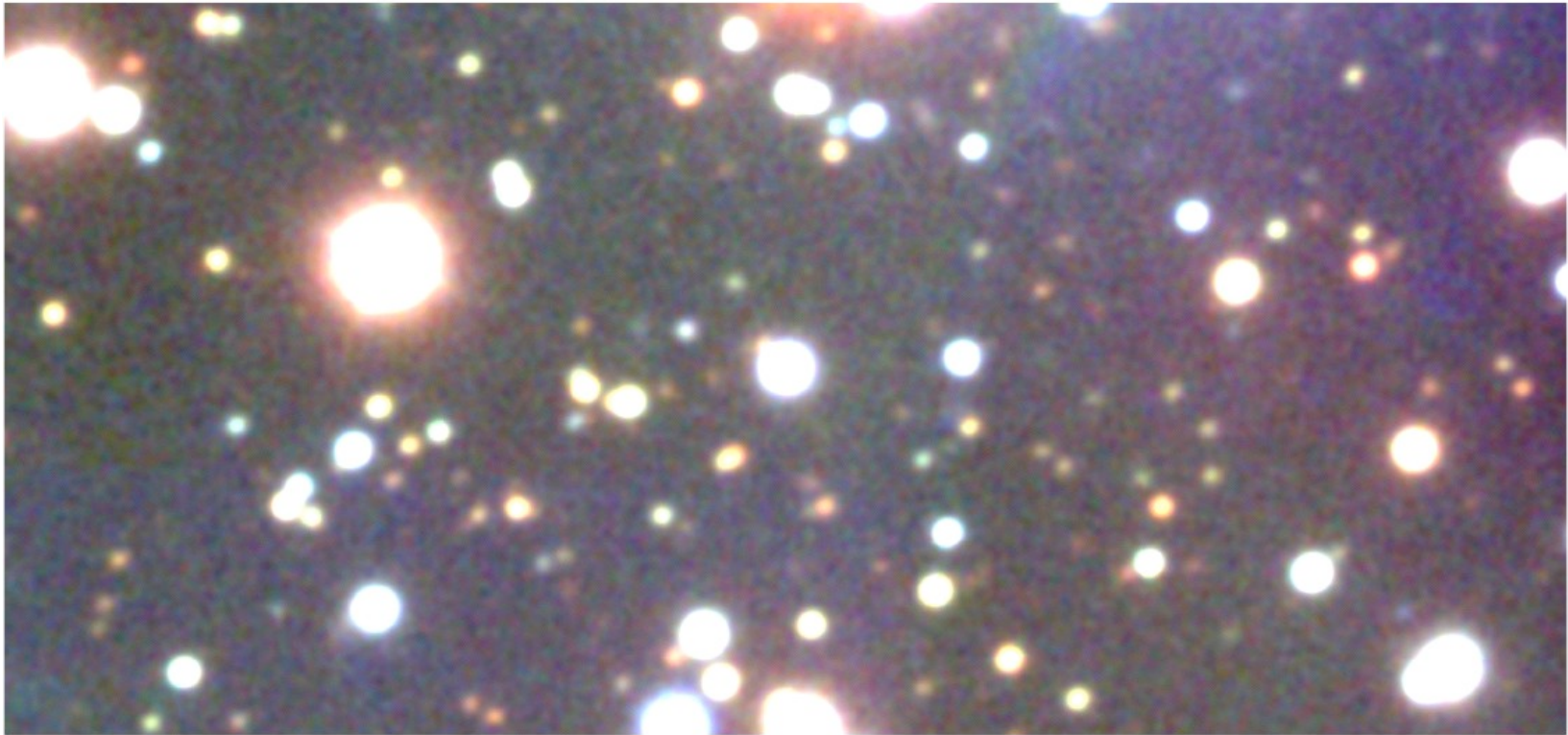
- Synchrotron X-rays?
 - requires $B \sim \mu\text{G}$, $1.6 \times 10^4 \leq \gamma \leq 2 \times 10^6$ and extra $\gamma \geq 10^8$ electrons
 - narrow γ range and a second e^- population?
- Inverse Compton X-rays?
 - requires $B \sim \text{mG}$, synchrotron self-absorption, and $\gamma_{\min} \leq 100$
 - IC-CMB requires $\Gamma > 60$; upstream Compton instead?

PKS 1421-490

- Unusual system demonstrates importance of larger surveys
- Knot B...
 - pushes the boundaries of known jet phenomena
 - if not a knot, then a new type of BL Lac
- More to come...

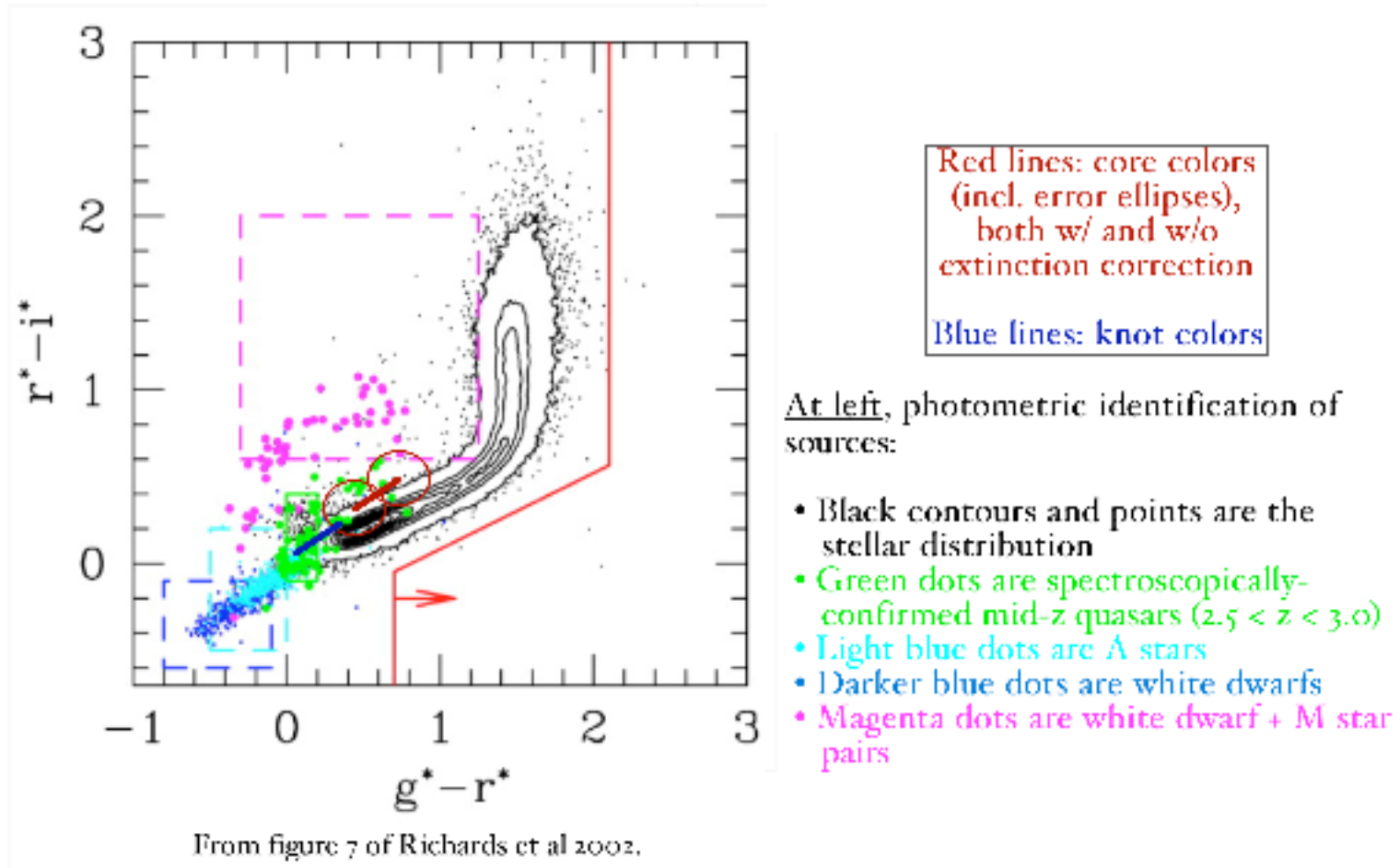
Supplemental material

1421-490: crowded field

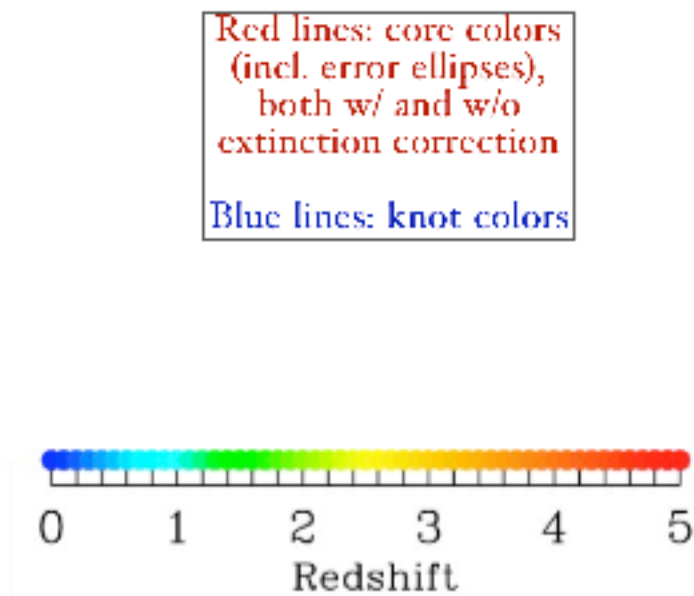


Magellan g', r' and i' images. 1421-490 B is at center of field.

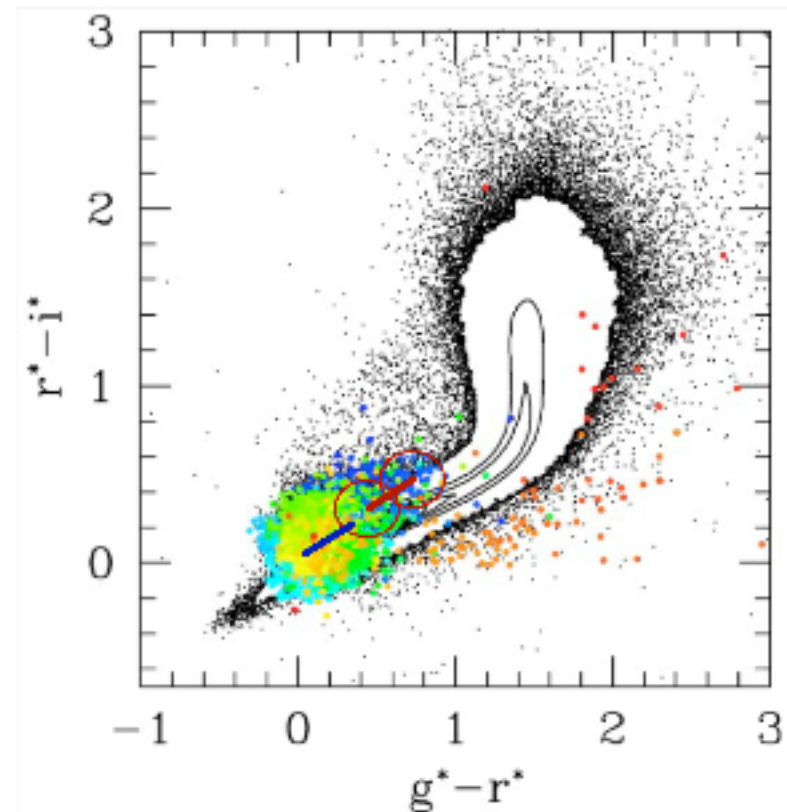
1421 ID: object type



1421 ID: photometric redshift

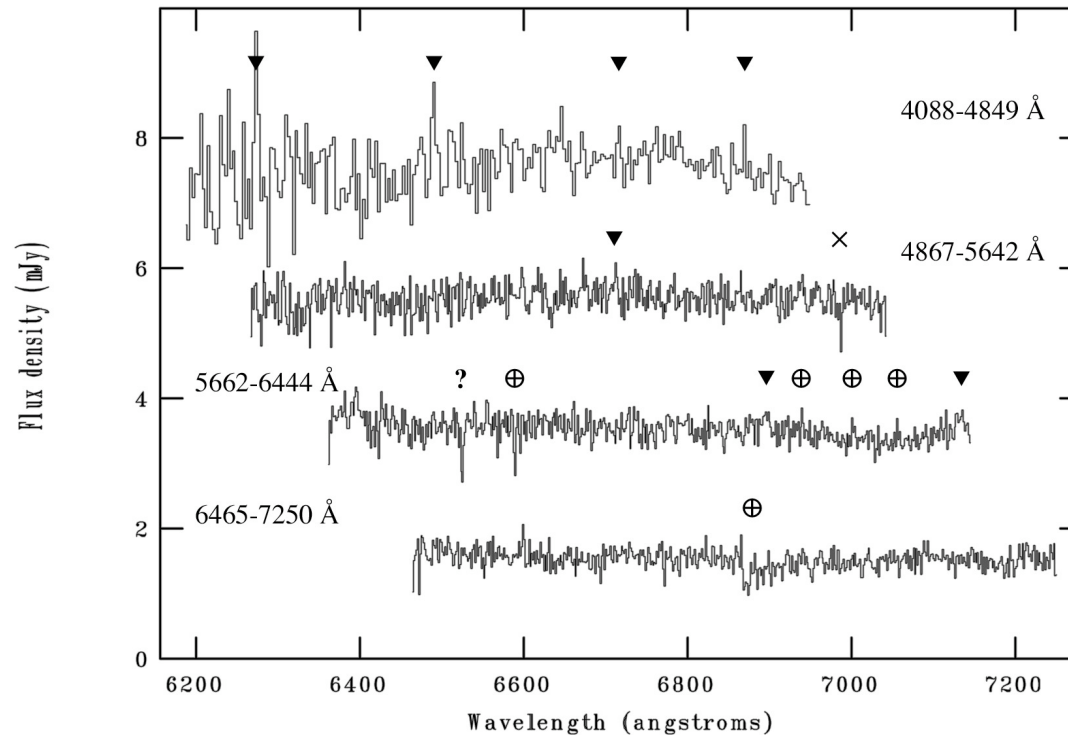


From figure 14 of Richards et al 2002 (AJ 123, 2945),
"Spectroscopic Target Selection in the SDSS:
The Quasar Sample"



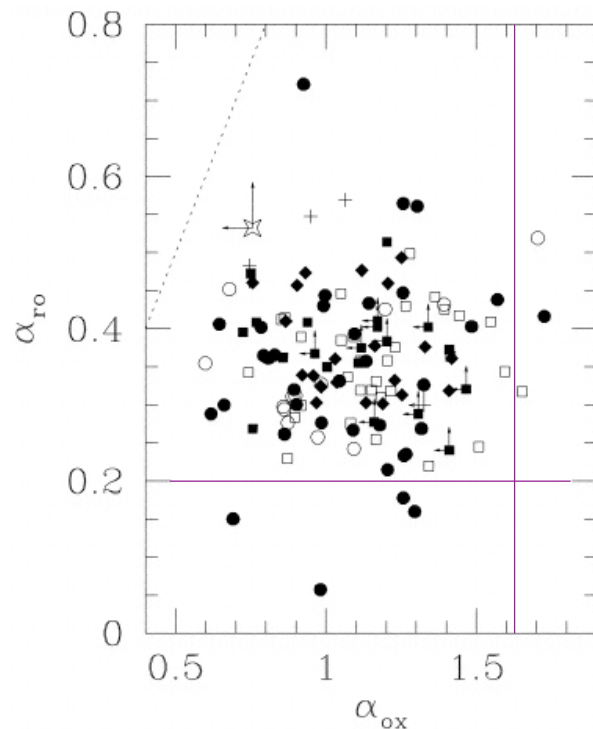
Above: redshift distribution of
quasars on color-color plane

Magellan spectrum of 1421-490B



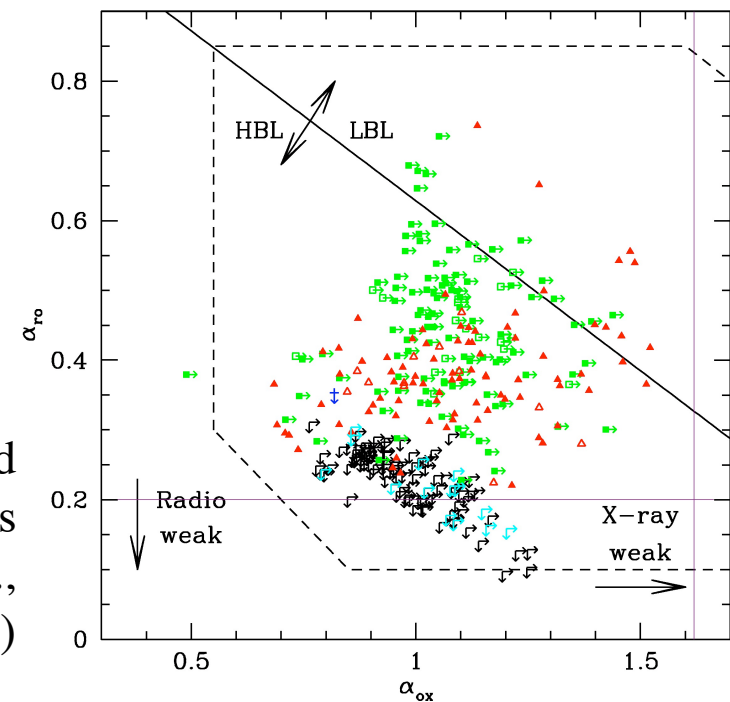
- Tentative absorption feature at 5825Å (“?”)
- Other markings are telluric, cosmic ray, or bad column residuals

PKS 1421-490 B vs. BL Lacs



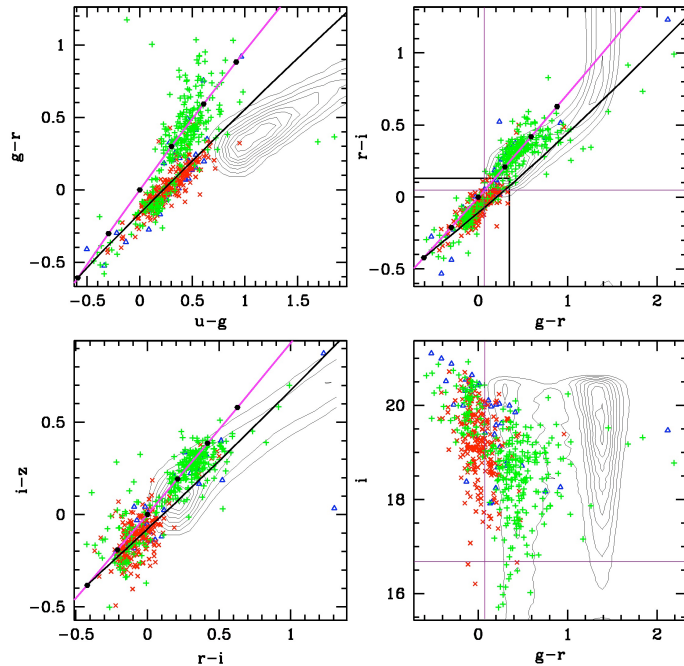
X-ray selected
BL Lac objects
(Worrall et al.
1999, ApJ 516,
163)

Optically selected
BL Lac candidates
(Collinge et al.,
astro-ph/0411620)



- outlier in broad band color-color plane
- also, no evidence of variability over 25-40 years

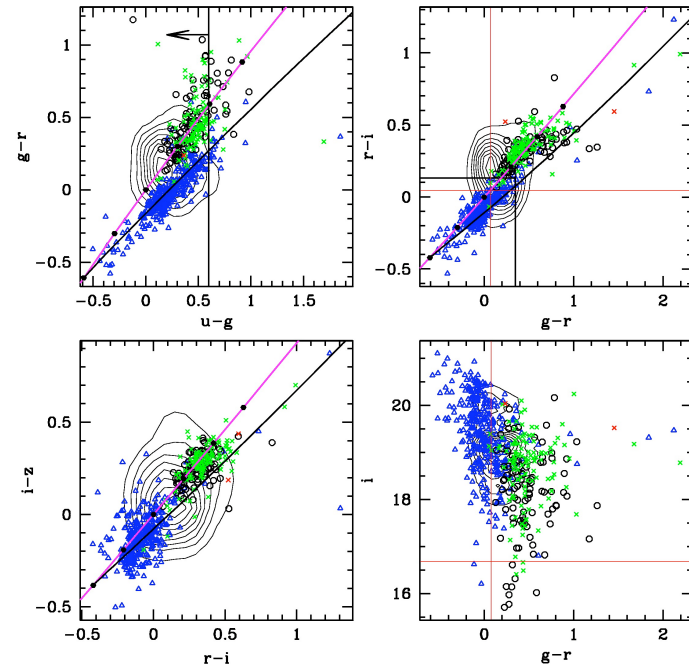
PKS 1421-490 B vs. SDSS BL Lac Candidates



Red points = high proper motion = likely non-BL Lacs

Magenta line = locus of power law spectra

Contours = stellar locus



Green points = radio or X-ray detected = likely BL Lacs

Contours = distribution of quasars

(from Collinge et al., astro-ph/0411620)