The Hunt for Red Quasars: Unveiling Luminous Obscured AGN

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Background: Importance of Luminous Obscured AGN

- Obscured AGN may represent critical stage in SMBH & galaxy co-evolution *e.g., Sanders+ 1988, Glikman+ 2004, Hopkins+ 2008, Banerji+ 2012*
  - powerful winds shape environment
  - regulate host galaxy star formation?
- Phase is short lived → *need wide-area surveys to identify these AGN*
- Stripe 82X: great dataset to search for obscured AGN & reddened quasars
  - 31 deg^2 X-ray survey w/ *XMM-Newton* & *Chandra LaMassa+ 2013a,b 2016; Ananna+ 2017*
  - Overlaps legacy Stripe 82 Sloan Digital Sky Survey field, boasting rich multi-wavelength coverage
- Combine multi-wavelength diagnostics to identify obscured quasar candidates:
  - $R - K$ v. X/O selection *e.g., Brusa+ 2010*
 - Optical "dropouts" with quasar mid-infrared colors

$R - K$ Sample: Selection & Ground Based Follow-up
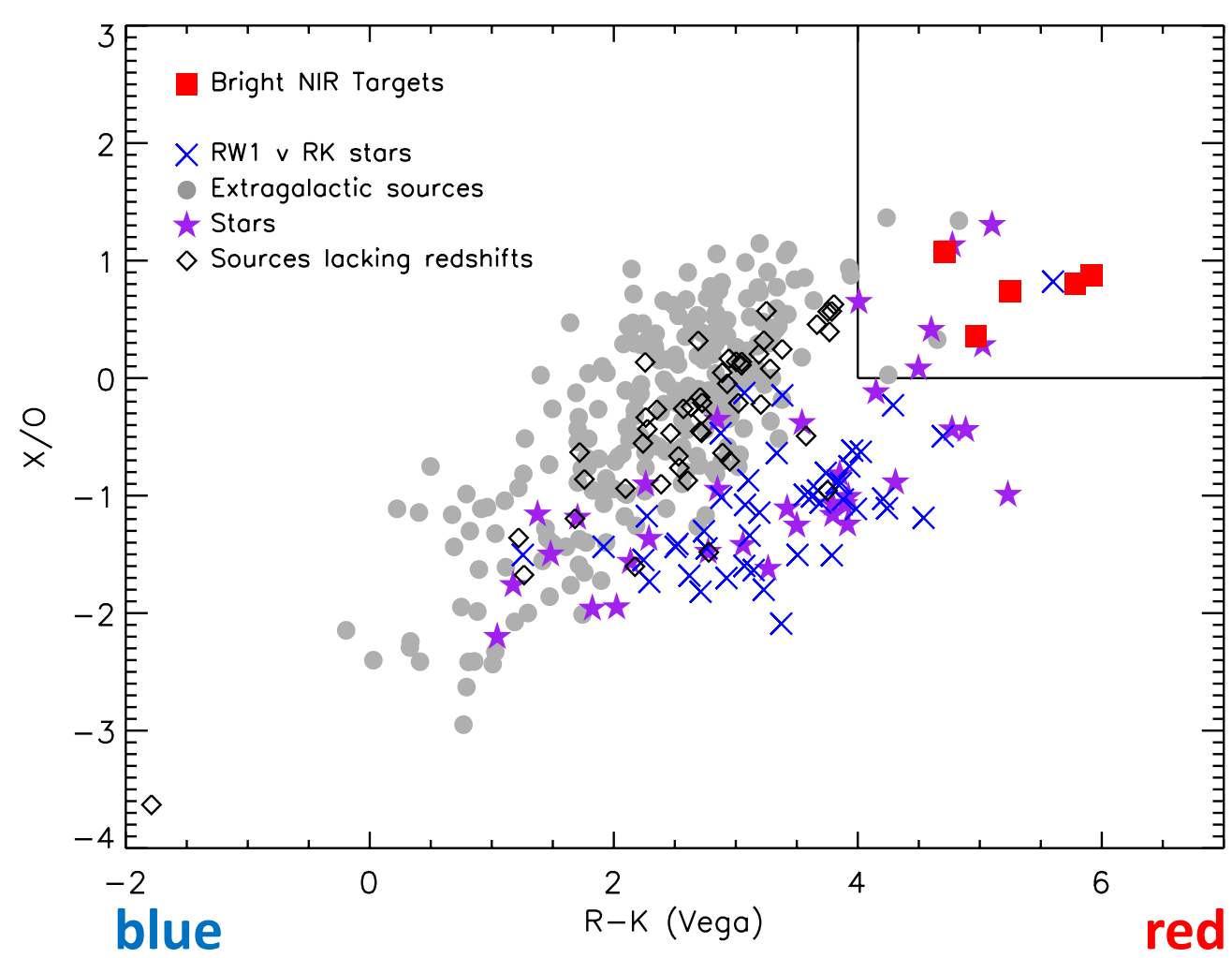
"Bright" Near Infrared (NIR) Sample
- K < 16 (Vega)
- $R - K$ > 4 color cut selects red objects
- X-ray to optical flux (X/O) > 0 cut minimizes stellar contamination
- boxed region defines **sample of 9**
  - 4 w/ SDSS spectra (not shown)
  - 5 followed up w/ Palomar TripleSpec in 2015 & 2016 (see below)
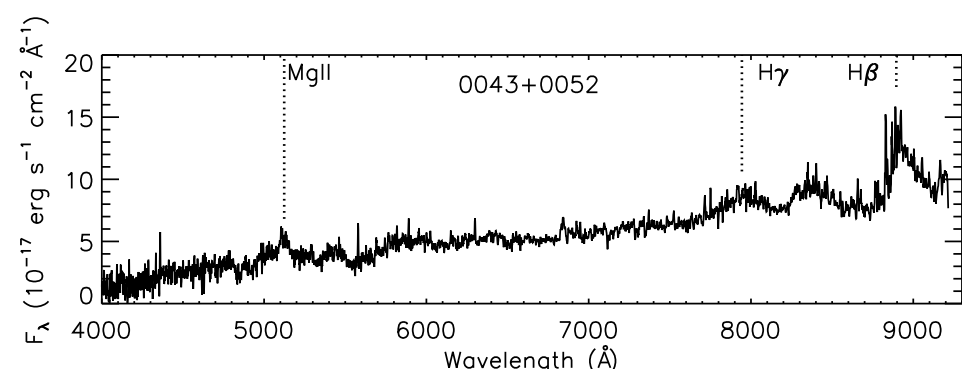
$R - K$ Sample: TripleSpec Spectra
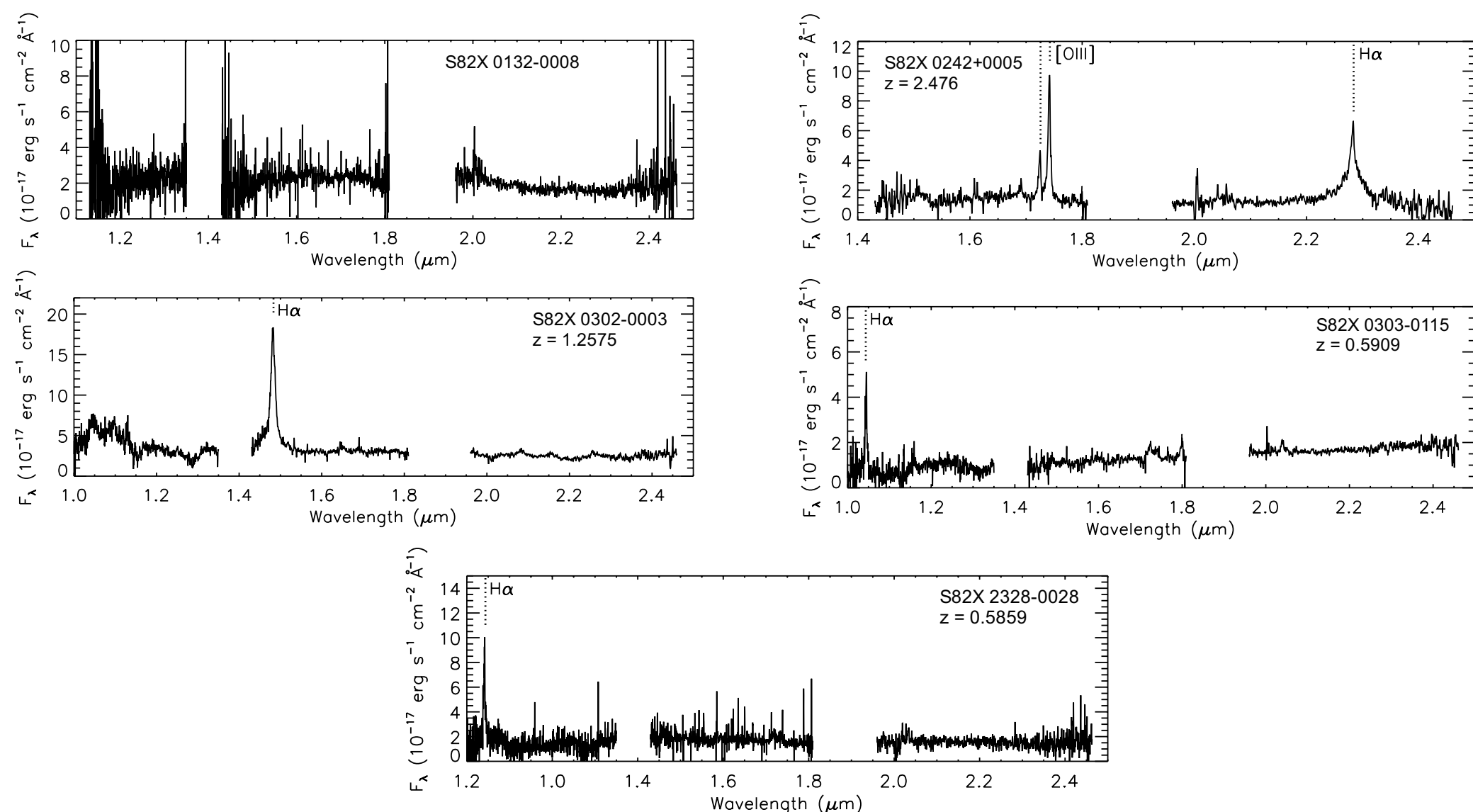
→ 4 out 5 TripleSpec sources spectroscopically identified

$R - K$ Sample: Results

- All sources are Type 1 AGN (FWHM ≥ 1300 km/s)
- 7/8 reddened by dust (red color for S82X 0011+0057 induced by radio jet)
- 4 reddened quasars show evidence of kinematics in Narrow Line Region: *indicative of predicted feedback?*
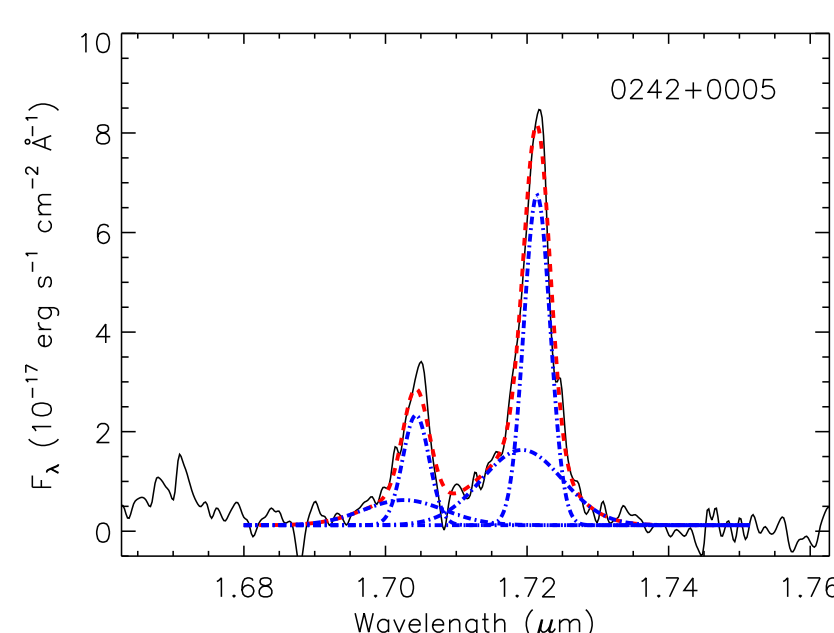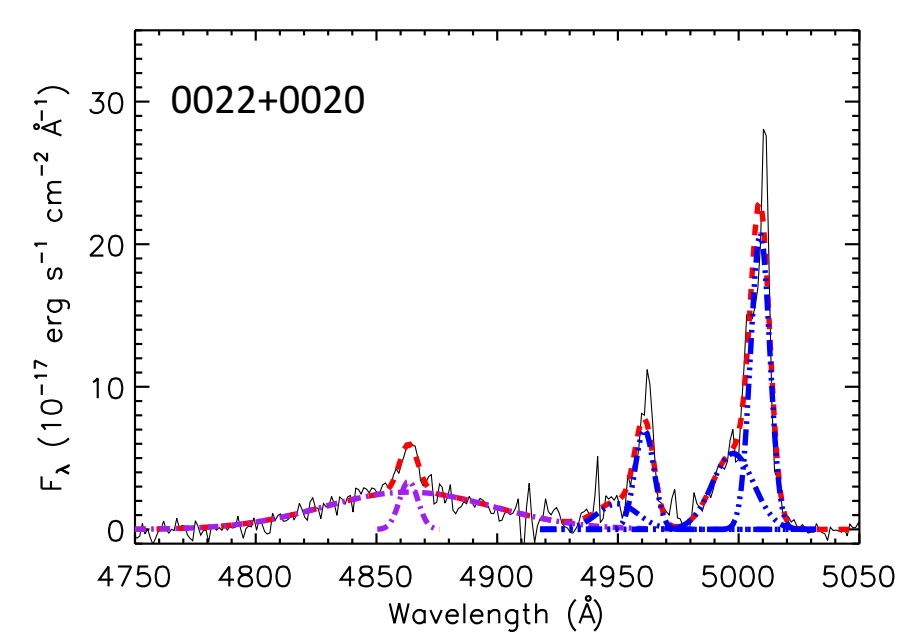
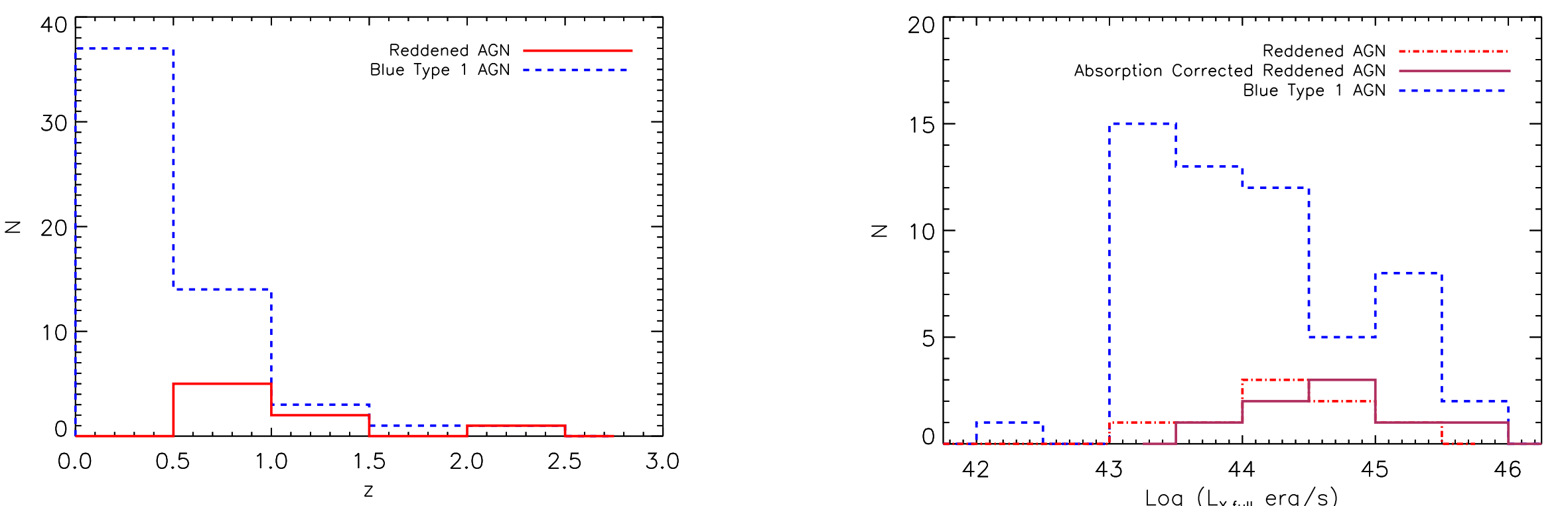

MgII quasar narrow absorption line system *Lundgren+ 2009*
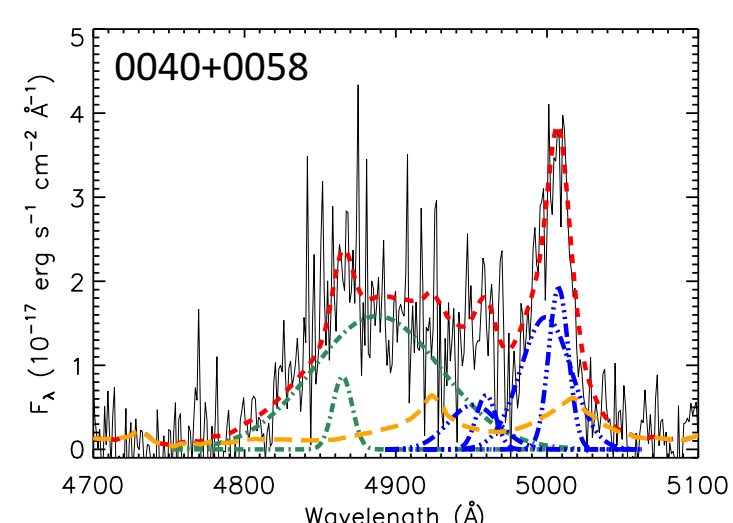
broadened [OIII] & blueshifted Hβ
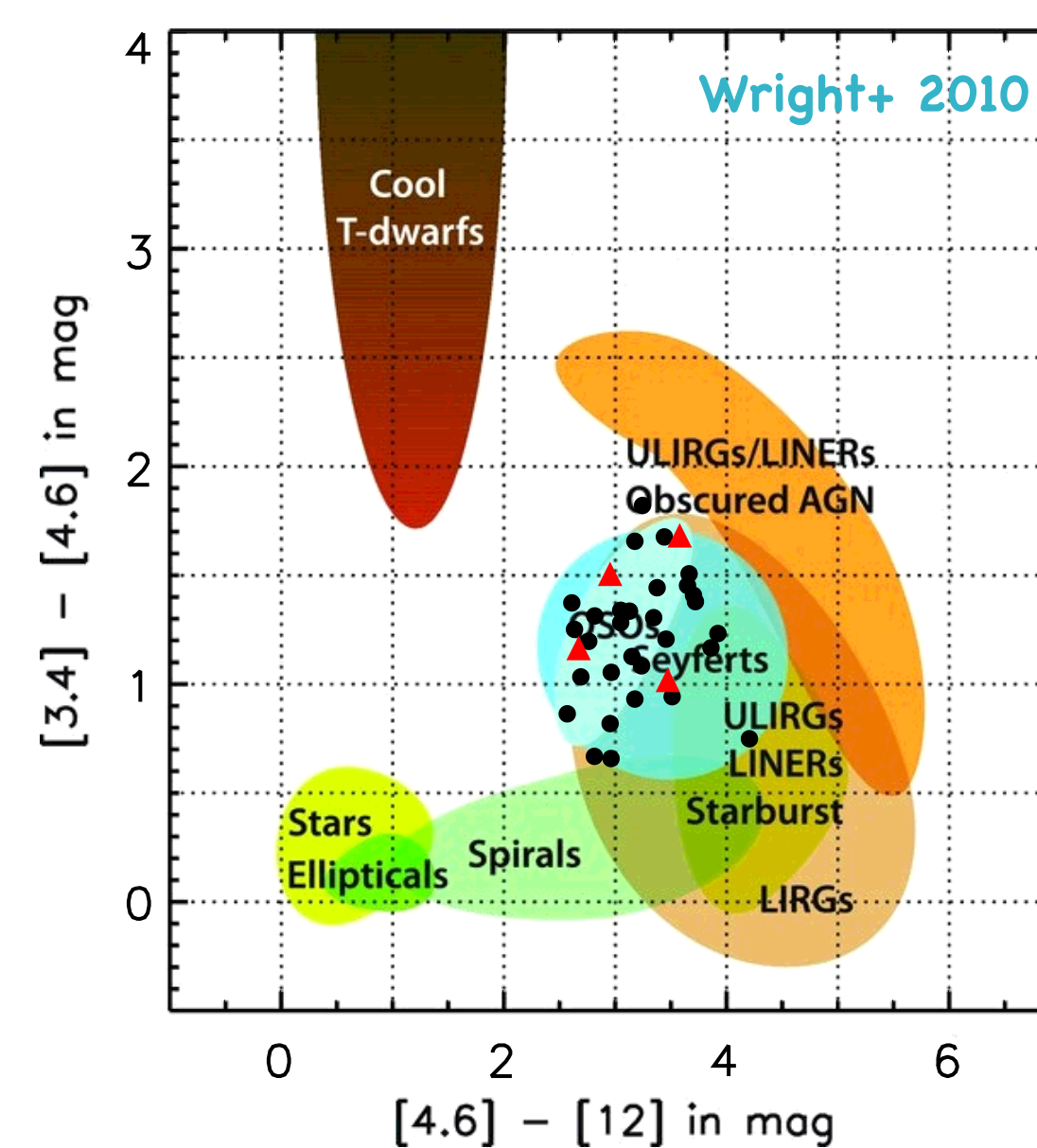
broadened [OIII]

$R - K$ Sample: More Luminous and Distant than Blue Type 1 AGN

Matched blue Type 1 AGN comparison sample selected from Stripe 82X:
- same optical & NIR magnitude limits
- $R - K$ < 3
- X/O > 0

Optical Dropout Sample: Selection & Ground Based Follow-up

"Faint" NIR Sample
- 17 < K < 19 (Vega)
- Not detected in single-epoch SDSS photometry
- Mid-infrared *WISE* colors in "QSO" locus of *WISE* color-color diagram
- **sample of 34**
  - none have pre-existing spectroscopy
  - 9 followed up w/ Keck NIRSPEC & Gemini GNIRS 2014 - 2016

Optical Dropout Sample: Keck NIRSPEC & Gemini GNIRS Spectra
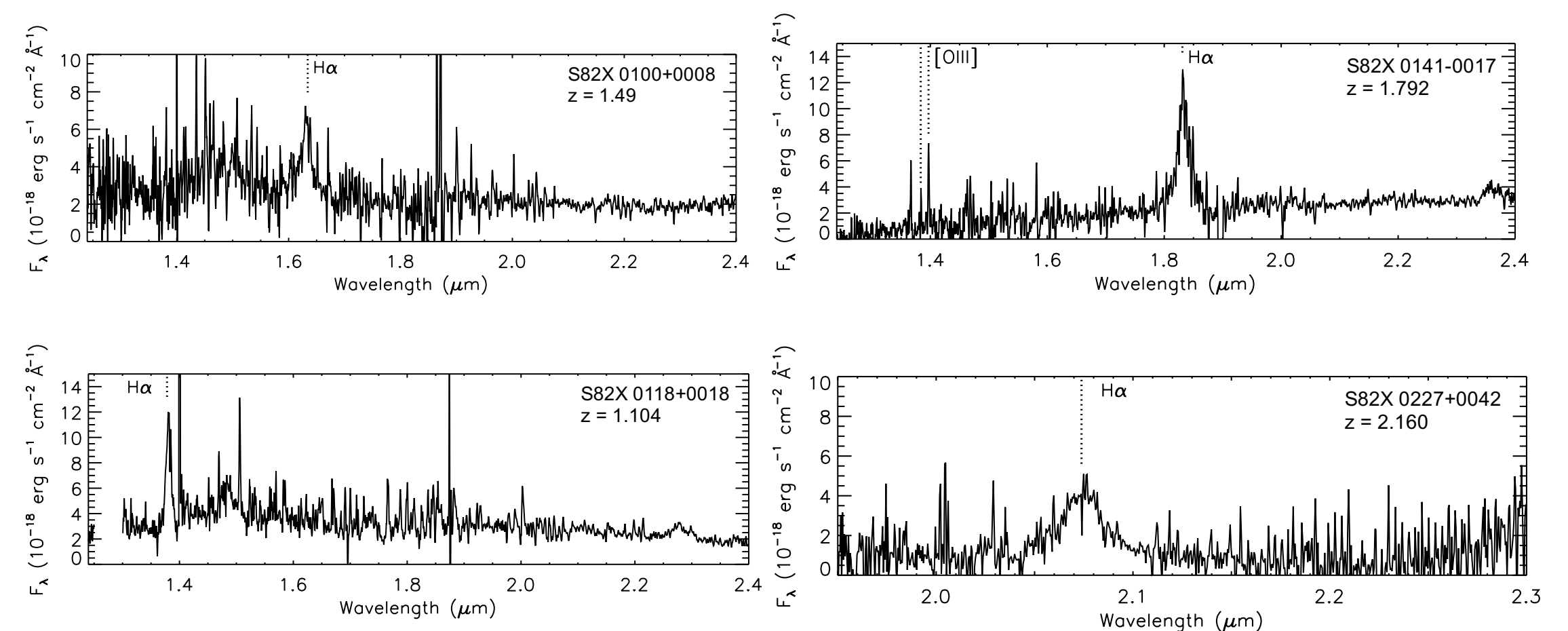
- 4 sources spectroscopically identified via broad Hα: **reddened Type 1 quasars**
- recovering luminous (L$_x$ > 10^{44} erg/s), z > 1 AGN missed by large optical surveys
  → demonstrated proof-of-concept for selection with pilot program

Future Work

- **$R - K$ Sample**: extend to K = 17 with Palomar TripleSpec
- **Optical Dropout Sample**: complete sample
  - 4 faintest targets will be observed with Gemini GNIRS 2018b
  - 6 targets will be observed with Keck NIRES 2018b
- Best opportunity to identify elusive high-*z* Type 2 quasars, compare with reddened Type 1 quasars

References

Ananna, T. T., Salvato, M., LaMassa, S. M., et al. 2017, ApJ, 850, 66
Banerji, M., McMahon, R. G., Hewett, P. C., et al. 2012, MNRAS, 427, 2275
Brusa, M., Civano, F., Comastri, A., et al. 2010, ApJ, 716, 348
Glikman, E., Gregg., M. D., Lacy, M., et al. 2004, ApJ 607, 60
Hopkins, P., Hernquist, L., Cox, T. J., et al. 2008, ApJS, 175, 356
LaMassa, S. M., Urry, C. M., Cappelluti, N., et al., 2016, ApJ, 817, 172
LaMassa, S. M., Urry, C. M., Cappelluti, N., et al., 2013b, MNRAS, 436, 3581
LaMassa, S. M., Urry, C. M, Glikman, E., et al., 2013a, MNRAS, 432, 1351
Lundgren, B., Brunner, R. J., York, D. G., et al. 2009, ApJ, 698, 819
Sanders, D. B., Soifer, B. T., Elias, J. H., et al. 1988 ApJ, 328, 35

See LaMassa et al. 2017 (ApJ, 847, 100)