# **AGN Science with the LSST**

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- ★ Magnitude range: 15.7 < i < 26.3,  $M_i <= -20$ .
- \* Redshift range: 0 < z < 7.5 (and beyond), using photo-z probability distribution functions.
- \* Classification and characterization based on joint likelihood distribution using:
  - 1. Colors
  - 2. Variability
  - 3. Astrometry
  - 4. Multiwavelength matching
- \* Obscuration and host-galaxy dilution will hinder AGN selection.

#### **Multicolor selection**



### Employing the six LSST bands: *ugrizy*

Variability



AGN have variability patterns distinct from those of variable stars

Astrometry

1) Lack of proper motion (down to ~ 1 mas yr<sup>-1</sup> at r ~ 24).

2) Differential chromatic refraction (change in band  $\lambda_{eff}$  with z).



## Multiwavelength matching



### Cross-correlating known AGN with LSST data

# 2. AGN by the Numbers



★ Expect ≈10<sup>8</sup> AGN detected in ≈10<sup>4</sup> deg<sup>2</sup> main LSST survey.

 ★ Additional detections of ~40000 (ultrafaint) AGN expected in ~200 deg<sup>2</sup> of Deep Drilling Fields (DDFs).

★ Expected discovery of ~8000 gravitationally lensed quasars including ~1000 systems with measurable time delays.

\* Expected discovery of at least 1000 AGN at z > 6.0 down to  $L_{opt} \sim 10^{44}$  erg s<sup>-1</sup>.

Chandra Deep Field-South Number Counts

# 3. Variability Studies and Gravitationally Lensed Quasars

Millions of AGN light curves with ~55-185 samplings per band (main survey) and ~10<sup>3</sup> samplings per band (DDFs) over 10 years spanning a temporal baseline of minutes-to-years.

\*Variability amplitude and timescale as a function of *L*, *z*,  $\lambda_{eff}$ , color, multiwavelength and spectroscopic properties (if available).

\*Photometric reverberation mapping (see two talks next session).

\*Power density spectra.

\*Accretion disk size and structure using microlensing.

\*Time delays in gravitationally lensed quasars.

\*Unresolved lensed-quasar candidates.

#### Need single-epoch spectra for notable/interesting AGN

# 4. Quasars at the End of the Dark Ages



#### Colors of high-redshift quasars

Expected numbers of z > 6 quasars

1) Between redshifts of 6.0 and 7.5: *i*- and *z*-band dropouts.

2) Above redshift 7.5, *y*-band dropouts having multiwavelength detections. **Need for spectroscopic follow-up** 

# 5. Transient AGN

Transient outbursts from galactic nuclei lasting over a month or more can occur when a star, a planet, or a gas cloud is tidally disrupted and partially accreted by the supermassive black hole.



Light curves of tidal disruption event candidates discovered in UV and optical surveys ★LSST is expected to discover and monitor ~1000 events per year.

\*LSST can trigger prompt multiwavelength follow-up.

★Provide tight constraints on the contribution of transient AGN to the faint end of the AGN luminosity function.

★Frequent monitoring and large area covered by LSST may allow detection of faint and rapid outbursts associated with intermediate-mass black holes in nuclei of nearby galaxies.

# 6. Future Work

★The LSST AGN Science Collaboration currently has 32 members working as a loose confederation, but hope to become a hardcore collaboration in the future as LSST construction proceeds.

\*A huge amount of work is needed on:

basic AGN selection
analysis of LSST simulations

3) detailed science planning

4) pooling of observational resources

5) strategies for spectroscopic follow-up

\*Additional feedback is welcome! Contact: <a href="https://www.lsstcorp.org">lsstcorp.org</a>

See also the AGN chapter in the LSST Science Book at:

http://www.lsst.org/files/docs/sciencebook/SB\_10.pdf