Probing the BLR and the Accretion Disk in Lensed Quasars using Microlensing

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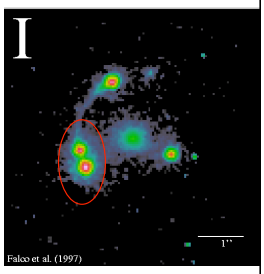
Lensed Quasars

- **Gravitational lens effect is achromatic**
- **Images near the caustic should have similar brightness and colors**



Flux (Color) Variation

$$m^{\lambda}_{\mathrm{obs},\,i}(t) = m^{\lambda}_{int}(t-\tau_i) - 2.5\log\left[\mu^{i}_{\lambda}(t)\right] + A^{i}_{\lambda}$$

Intrinsic magnitude of the QSO

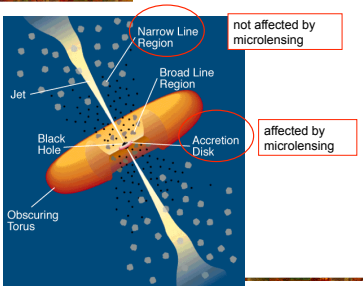
Time delay of image *i*

Magnification of image *i* (including microlensing)

Dust extinction at image *i*

months/years of broad-band monitoring

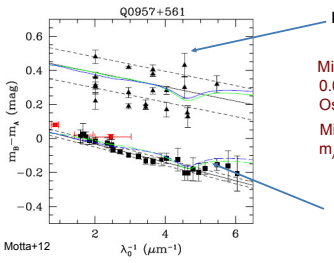
Spectroscopy



Problems and Limitations

- Spectrum Cross-contamination
- Long-slit Losses
- Complex emission line (narrow + broad)
- BEL microlensing
- Lens galaxy continuum contamination
- Time delay

Spectroscopy: microlensing



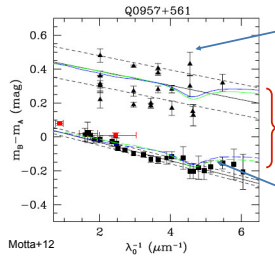
Emission line core

Microlensing magnitudes: 0.05-0.25 mag (Pelt+98, Oscoz+02)

Microlensing zero point (m_B-m_A) taken as 0 or -0.05 mag.

Continuum

Spectroscopy: microlensing



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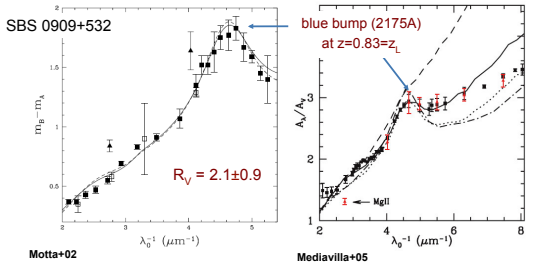
Spectroscopy: dust extinction



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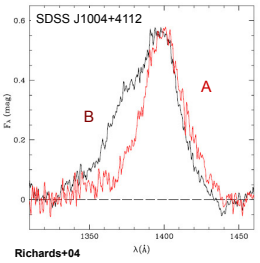
BLR Microlensing



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Size of the BLR

$r_s \propto (M/M_{sun})^{1/2}$

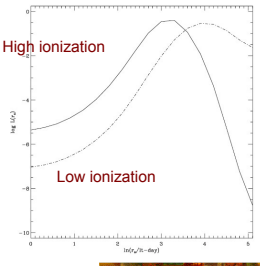
Fraction of mass 5%

$M=1M_{sun}$

$r_s=24^{+15}_{-15}$ lt-day (HIL)

$r_s=55^{+150}_{-35}$ lt-day (LIL)

Agree with reverberation mapping estimates.



Guerras+13

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Chromatic Microlensing

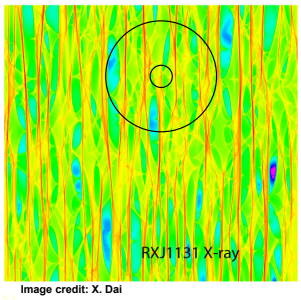

Image credit: X. Dai

Microlensing magnification depends on the source size

Larger sources have smaller microlensing magnification

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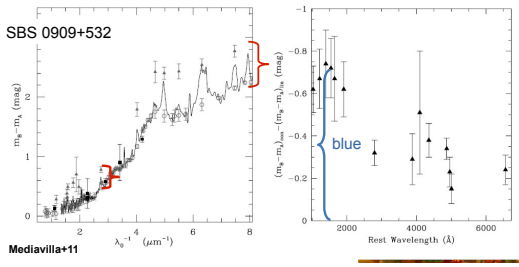
Chromatic Microlensing



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Size of QSO Accretion Disk

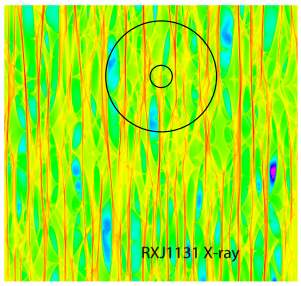


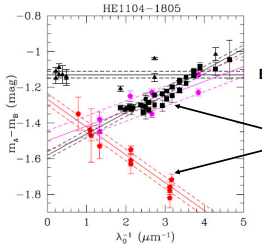
Image credit: X. Dai

Accretion disk: $I \propto \exp(-R^2/2r_s^2)$, radius: $r_s \propto \lambda^p$

$\alpha = 0.1$

$M=1M_{sun}$

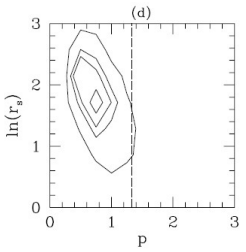
Size of QSO Accretion Disk



Emission lines

Microlensed continuum (different epochs)

Size of QSO Accretion Disk



HE 1104-1805

Logarithmic grid in r_s

$r_s = 6^{+2}_{-1}$ lt day

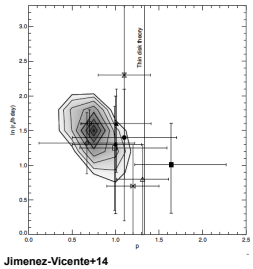
$15.5^{+5.2}_{-2.6} \times 10^{15}$ cm

$p = 0.7 \pm 0.1$

$r_s = R_{1/2}(\lambda 4311) = 8 \pm 2$ lt-day

$(76 \pm 19) \times 10^{17}$ cm

Average Size of Accretion Disk



Jimenez-Vicente+14

8 systems

Logarithmic grid in r_s

r_s (λ1026)= $4.5^{+1.5}_{-1.5}$ lt day

$p = 0.75 \pm 0.2$

Conclusions

- Spectroscopy provides simultaneous continuum and emission line measurements to distinguish microlensing in the continuum, BEL from dust extinction. It allow us to identify long lasting microlensing events.
- Chromatic microlensing allows to estimate the size of the emitting region and the temperature profile.