What can we learn about quasars and unification scheme with the microlensing technique?

Dominique Sluse

(University of Liège, Belgium)

with T. Anguita (Uni. A. Bello, Chile), L. Braibant, D. Hutsemékers (U. Liège), P. Riaud, R.W. Schmidt, J. Wambsganss (U. Heidelberg), F. Courbin (EPFL, Lausanne)

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Introduction

\[ \eta_0 = \sqrt{\frac{4G\langle M \rangle}{c^2}} \frac{D_{os}D_{ls}}{D_{ol}} \]

\[ \approx 2.03 \times 10^{16} \sqrt{\frac{\langle M \rangle}{0.3M_\odot}} \text{ cm} \]

(Credit: Courbin, Saha, Schechter 2003; Claeskens+ 2006)
Introduction

\[ T_{\text{eff}} \propto r^{-1/\nu} \]
\[ \sigma_0(1126 \, \text{Å}) = 1 \, \text{l-d} \]
\[ \nu = 4/3 \]

4000 days

Courtesy: T. Anguita
$T_{\text{eff}} \propto r^{-1/\nu}$

$\sigma_0(1126 \text{ Å}) = 0.1 \text{ l-d}$

$\nu = 4/3$

4000 days

Courtesy: T. Anguita
Accretion disk: Size and Temperature

\[ T_{\text{eff}} \propto r^{-1/\nu} \implies r \propto \lambda^\nu \]

w. Standard value: \( \nu_{SS} = 4/3 \)

<table>
<thead>
<tr>
<th>Work</th>
<th>Characteristics</th>
<th>Size</th>
<th>Slope (( \nu ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morgan+ (2010)</td>
<td>Multi-epoch</td>
<td>( R_{ML} (2660\text{Å}) &gt; 1.8\pm1.6 \ R_{SS} )</td>
<td>Indirect ( \nu \sim 2.0 \implies R_{ML} \sim R_{SS} )</td>
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<tr>
<td></td>
<td>1 band</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>11 systems</td>
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<tr>
<td>Blackburne+ (2011)</td>
<td>Single epoch</td>
<td>( R_{ML} (1736\text{Å}) &gt; 10^{+7.5}<em>{-7.5} \ R</em>{SS} )</td>
<td>( \nu = 0.17 \pm 0.15 \pm 0.13 )</td>
</tr>
<tr>
<td></td>
<td>7 bands</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>12 systems</td>
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<tr>
<td>Eigenbrod+ (2008)</td>
<td>Multi-epoch (3yrs) Spectroscopy</td>
<td>( R_{ML} (2000) &gt; 2.3^{+1.7}<em>{-1.4} \ R</em>{SS} )</td>
<td>( \nu = 1.2 \pm 0.3 )</td>
</tr>
<tr>
<td></td>
<td>1 system</td>
<td></td>
<td></td>
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<tr>
<td>Poindexter+ (2008)</td>
<td>Multi-epochs</td>
<td>( R_{ML} &gt; R_{SS} )</td>
<td>( \nu ) Compatible with ( \nu_{SS} )</td>
</tr>
<tr>
<td>Mosquera+ (2011)</td>
<td>Multi-bands</td>
<td></td>
<td>But ( \nu &gt; \nu_{SS} ) favoured by</td>
</tr>
<tr>
<td>Blackburne+ (2013)</td>
<td>Individual systems</td>
<td></td>
<td>B13; ( \nu &lt; \nu_{SS} ) by P08</td>
</tr>
</tbody>
</table>

Accretion disk: Cloverleaf

Note that the flux of D is rescaled: \( \text{D} \times \frac{M}{\mu} \)

\( M = \text{Macro magnification} \)

\( \mu = \text{micro magnification} \)

Sluse et al. 2015
arXiv:1508.05394
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Accretion disk: "Extended" / scattered continuum

Properties:

• About 30% of the total UV-continuum flux (could be in principle larger)

• Chromaticity: Same amount detected around $\lambda\sim1216$ Å and $\lambda\sim1549$ Å (thanks to ML and to the absorber in Ly$\alpha$ and CIV).

• Time variability: Fraction of flux which comes from “extended” continuum could vary with time (20% of the total UV-continuum in 2000).

• No (little) “extended” continuum at $\lambda\sim4861$ Å? (No change of $\mu$ at 4861 Å between 2005 and 2011 despite of a change of the effective $\mu$ in the UV).

• Emitted on scales smaller than the host galaxy. Could be (polar) scattered light at the origin of polarization also observed in this object (Hutsemékers et al., submitted)
Accretion disk: Compact continuum

H1413+117

Little impact of extended continuum on the analysis

Sluse et al. 2015 arXiv:1508.05394
Accretion disk: Orientation (literature results)

Analysis of Einstein cross

11 years lightcurve (from OGLE)
Splitted in 2 (LC1 and LC2)

See also Blackburne+ 2013
for $\cos(i)$ in HE1104-1805


$z_s = 1.695 \quad z_l = 0.039$
BLR: Size and geometry

ML size of the CIV in the Einstein cross compared w. RM

Microlensing

Blum size and geometry

Because of its larger size, the torus is only weakly microlensed. Deformation of the SED are expected for large amplitude of microlensing (mix between AD and torus ML).

Absence of ML at 11.7 μm in Einstein cross ruled out synchrotron MIR emission (Agol+2000)
Conclusions

• AD sizes from ML are larger than theory (SS): Tension at the 1-2 $\sigma$ level for individual works, but all over-estimate of the size.

• Evidence for extended/scattered continuum (30% of UV-continuum emission): may not solve ML-theory size discrepancies ... But it is there!

• Also ML constraints on AD orientation, AD temperature profile, BLR size, BLR geometry and identify differences in BLR structure between lines in a given object

• Still a lot to be done: pin-down uncertainties, need for data, manpower, combine ML with other techniques, independent analysis of existing data.
Accretion disk: Cloverleaf

Note that the flux of D is rescaled: $D \times \frac{M}{\mu}$

$M = \text{Macro magnification}$

$\mu = \text{micro magnification}$
Accretion disk: Cloverleaf

Using image A as a reference, and combining the spectra of A & D rescaled by $M$ and $\mu$, we can isolate:

$$\frac{F_M}{F_{M\mu}} = \text{fraction of flux unaffected by microlensing}$$

$$\frac{F_{M\mu}}{F_{M\mu}} = \text{fraction of flux affected by microlensing}$$

- $F_M$ + $F_{M\mu}$ = $F_A$

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Accretion disk: “Extended”

Using image A as a reference, and combining the spectra of A & D rescaled by M and µ, we can isolate:

\[ \frac{F_M}{\text{flux unaffected by microlensing}} = \frac{F_{M\mu}}{\text{flux affected by microlensing}} \]

\[ F_M + F_{M\mu} = F_A \]

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