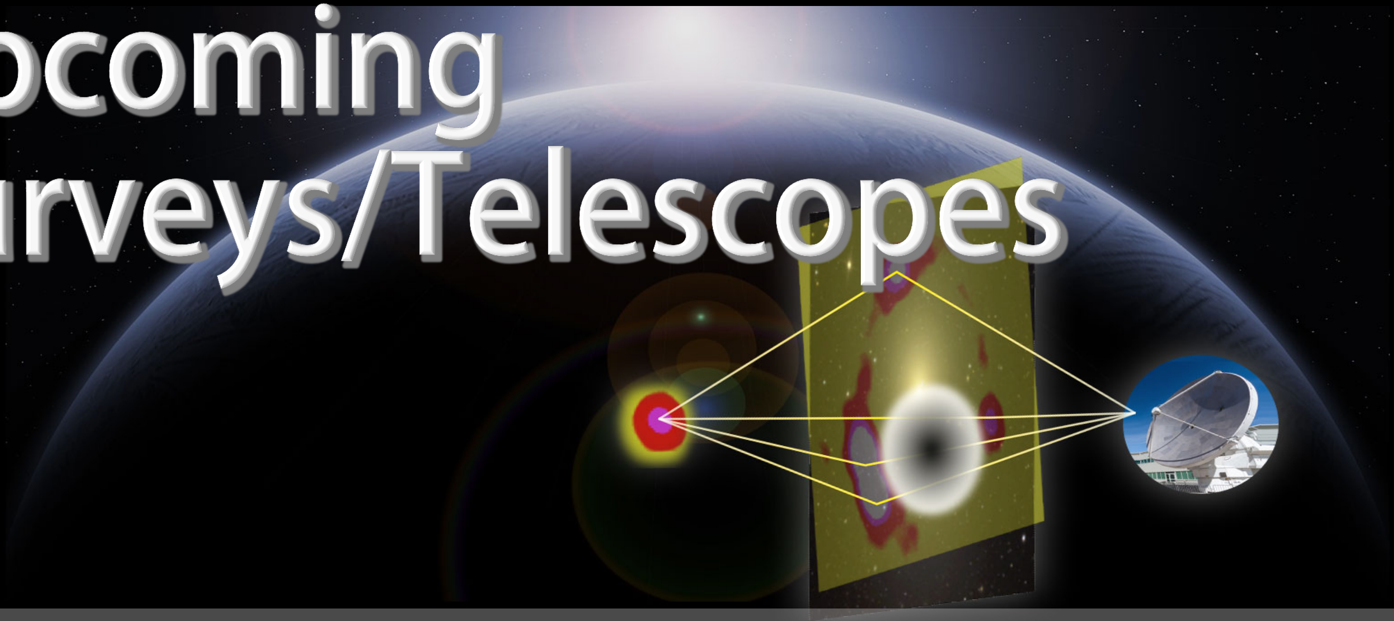
Panel Discussion (2nd day)

Dark Matter Science with Upcoming Surveys/Telescopes



Kaiki T. Inoue(lead) Ariel Goobar Jose Diego
Thomas Collett DanDan Xu Ayuki Kamada

- Dark Matter – What we know and what we do not know   (15min)
- Astrophysical Observations for Detecting Dark Matter – What is the best way? (15min)
- Observational Strategy for Detecting Dark Matter – What can we do with upcoming survey? (15min)
- Dark Matter Science as an Interdisciplinary Field – How we can work together? (10min)

Dark Matter – What we know and what we do not know

- Are WIMPs really the most plausible candidates?

- Small-scale problems (missing satellites, TBTF, core-cusp, plane distribution) and non-WIMPS candidates
  - ・Kinetic property (WDM superWIMP CHAMP, …) : interaction
  - ・(SIDM, coupling with Standard Model): wave (FDM Ultra-light bosons)

Astrophysical Observations for Detecting Dark Matter – What is the best way?

- Cosmological objects: Strong lensing due to line-of-sight structures/subhalos: flux ratios, astrometric shifts, time delays, Microlensing by compact objects (versus Lyman-alpha clouds, weak lensing by clusters)

- Local objects: Dwarf galaxis, Ultra Diffuse Galaxies, Globular clusters, high-velocity HI clouds, tidal streams, halo stars

- Gravitational waves: Wave effects, precise time delay, multi-messenger

Probing Dark Matter with Strong Lensing

➢Pros

- ✓ Probe gravity directly
- ✓ Probe small-scale clustering
- ✓ Probe cosmological fluctuations

➢Cons

- ✓ Complex modeling (highly non-linear)
- ✓ Ambiguity due to feedback (UV radiation , star formation, AGN, etc)

Observational Strategy for Detecting Dark Matter – What can we do with upcoming survey?

- Strong lensing Euclid LSST SKA, ALMA2, ngVLA, JWST, TMT,ELT
- Weak lensing & clustering Euclid LSST SKA, WFIRST
- High energy (annhilation+synchrotron) SKA
- Gravitational waves LIGO LISA DECIGO
- Direct and indirect methods (xenon experiments, CTA)

To what scales we can go?

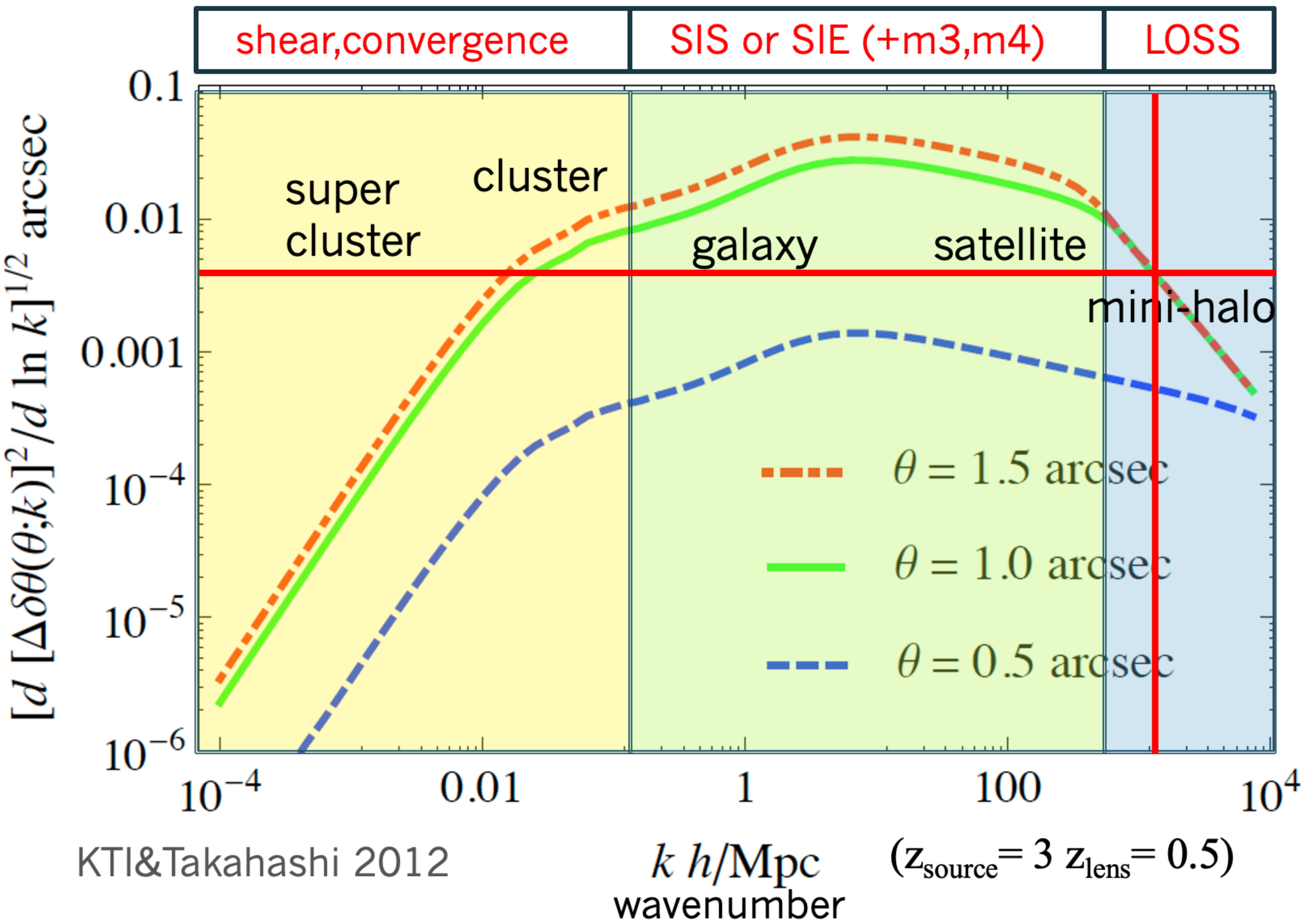
- Flux ratios: Source size limit: MIR(z~3) source radius~1-2pc
  radio jet/core(z~3) size>10pc

➡ Flux ratios of ~10% MIR 2pc → >10^5 solar mass
~1% MIR 1pc → >10^3 solar mass

- Relative astrometric shifts:

➡

Astrometric shift perturbation



KTI&Takahashi 2012

To what scales we can probe?

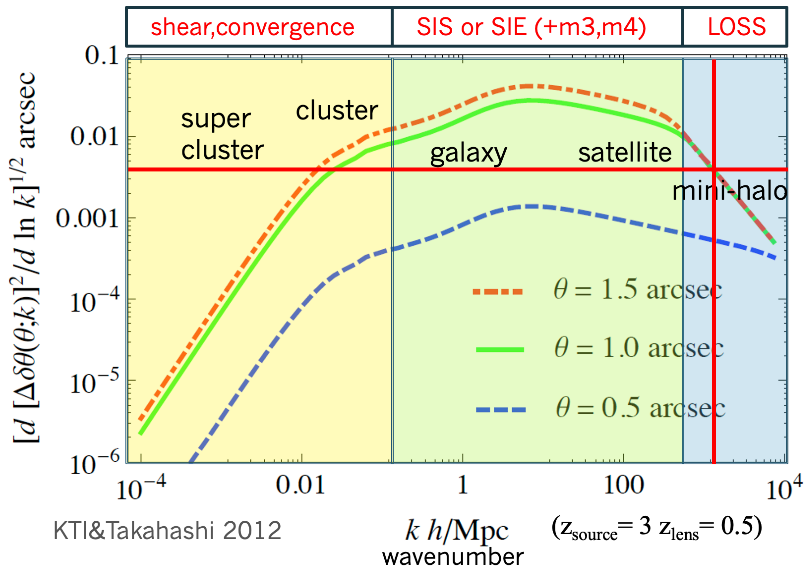
- Flux ratios: Source size limit: MIR(z~3) source radius~1-2pc
  radio jet/core(z~3) size>10pc

  ➡ Flux ratios of ~10% MIR 2pc → >10^5 solar mass
  ~1% MIR 1pc → >10^3 solar mass

- Relative astrometric shifts:

  ➡ 10mas →10^7 solar mass
  1mas →10^3 solar mass

Astrometric shift perturbation



Observational Strategy for Detecting Dark Matter – What can we do with upcoming survey?

- Strong lensing Euclid LSST SKA, ALMA2, ngVLA, JWST, TMT,ELT
- Weak lensing & clustering Euclid LSST SKA, WFIRST
- High energy (annhilation+synchrotron) SKA
- Gravitational waves LIGO LISA DECIGO
- Direct and indirect methods (xenon experiments, CTA)

Dark Matter Science as an Interdisciplinary Field – How we can work together?

- DM scientists are involved in a wide range of fields:
  particle physics, galaxy formation, cosmology, gravity (quantum/classical)
- As a consequence, communication between different communities is difficult.
- As a consequence, the 'bias' in the confidence level of results depends on communities.
- How we can tackle these problems? How we can work together?

- Dark Matter – What we know and what we do not know

- Astrophysical Observations for Detecting Dark Matter – What is the best way?

- Observational Strategy for Detecting Dark Matter – What can we do with upcoming survey?

- Dark Matter Science as an Interdisciplinary Field – How we can work together?