Survey of Gravitationally-lensed Objects in HSC Imaging: SuGOHI

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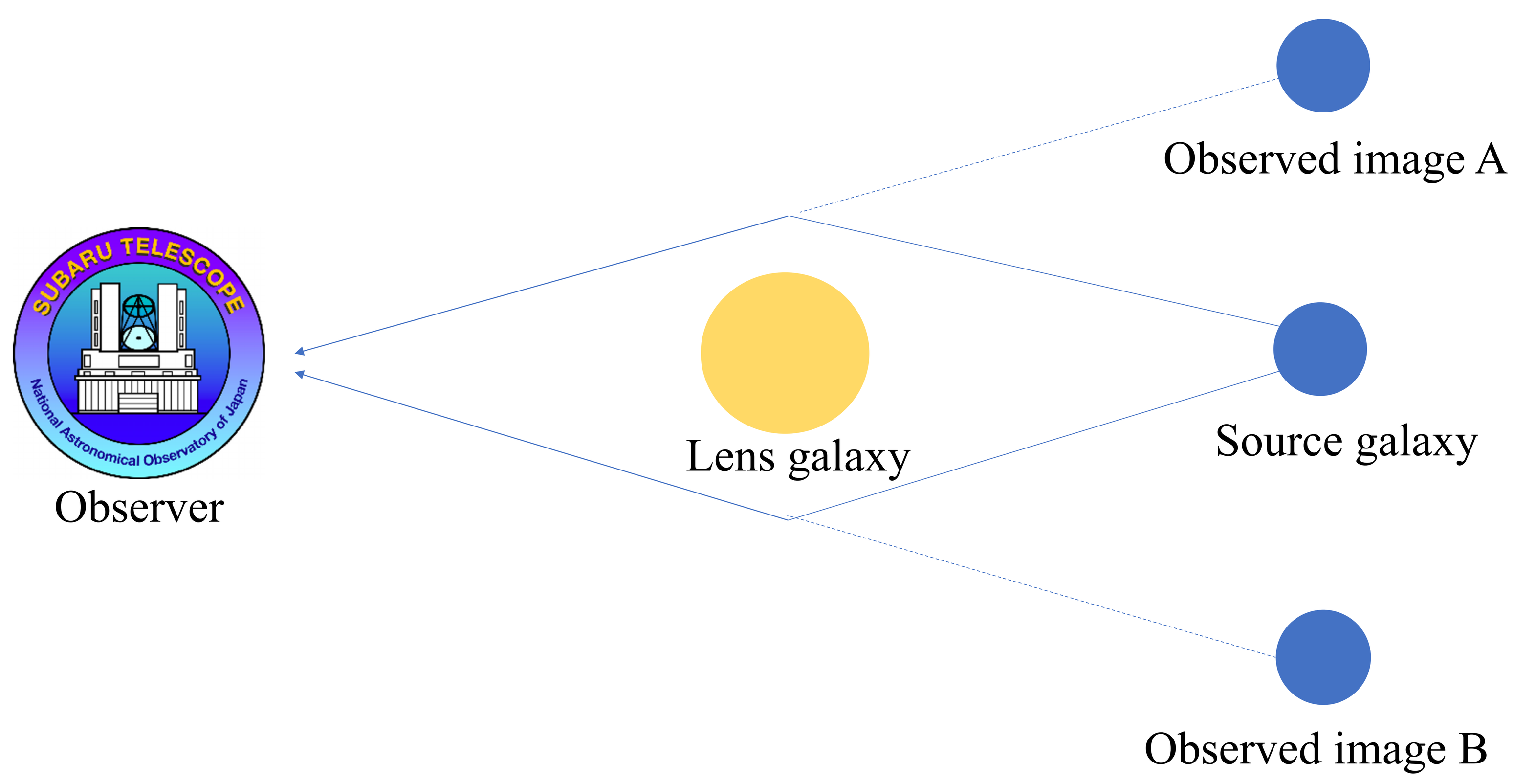
1. Strong gravitational lensing



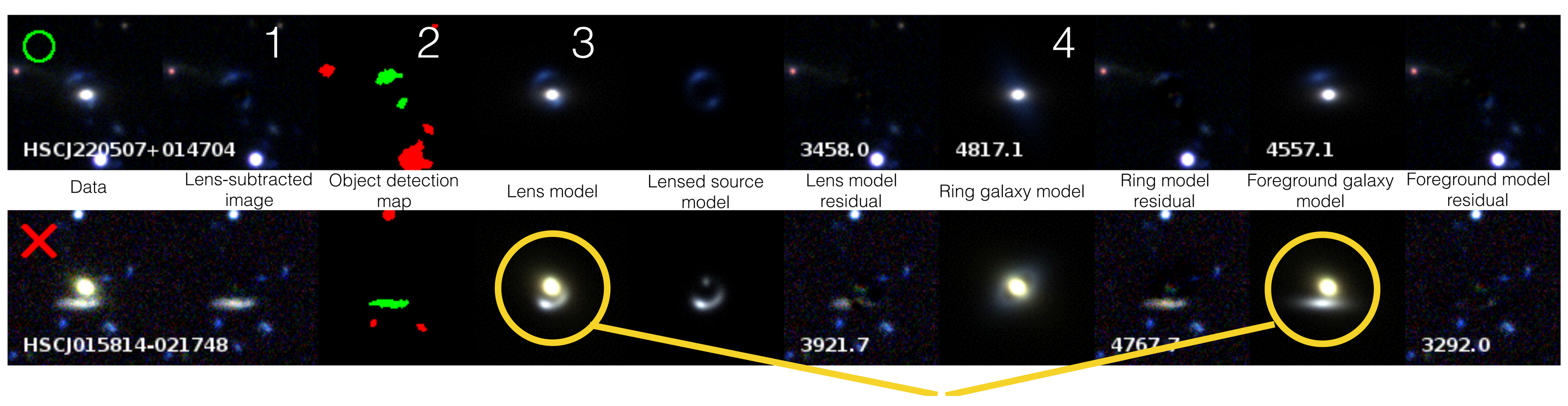
Schematics of a strong lens system: light from a background galaxy is deflected by a foreground massive object, such that multiple images of the same galaxy are formed

- Very powerful tool to study the structure of galaxies: few % precision on total projected mass within Einstein radius
- Rare phenomenon: requires almost perfect alignment between lens and source. Roughly one in a thousand galaxies is a lens.
- Only a few hundred galaxy-scale strong lens systems currently known
- Can be used to answer the following questions:
  - How do massive elliptical galaxies grow in time?
  - How does their stellar content change as a result of mergers with smaller galaxies?
  - How does the distribution of dark matter respond to the infall of gas or the presence of a central black hole?
- More lenses are needed, particularly at redshift $z > 0.5$.

2. Automatic detection of strong lenses

We developed a lens finding algorithm, named YattaLens, to look for lenses among massive galaxies in multi-band imaging data. YattaLens articulates itself over the following steps:

1. For each galaxy, fits a model surface brightness profile to remove from the image the contribution of the lens light
2. Looks for blue tangentially elongated objects around the galaxy center
3. If an arc is detected (roughly, this happens for ~10% of the objects), fits a lens model to the image
4. Compares the best-fit lens model with alternative non-lens models, to determine the likelihood of it being a lens



This system is better described by a model with a foreground object, compared to a model with a lensed background source, therefore the candidate is rejected

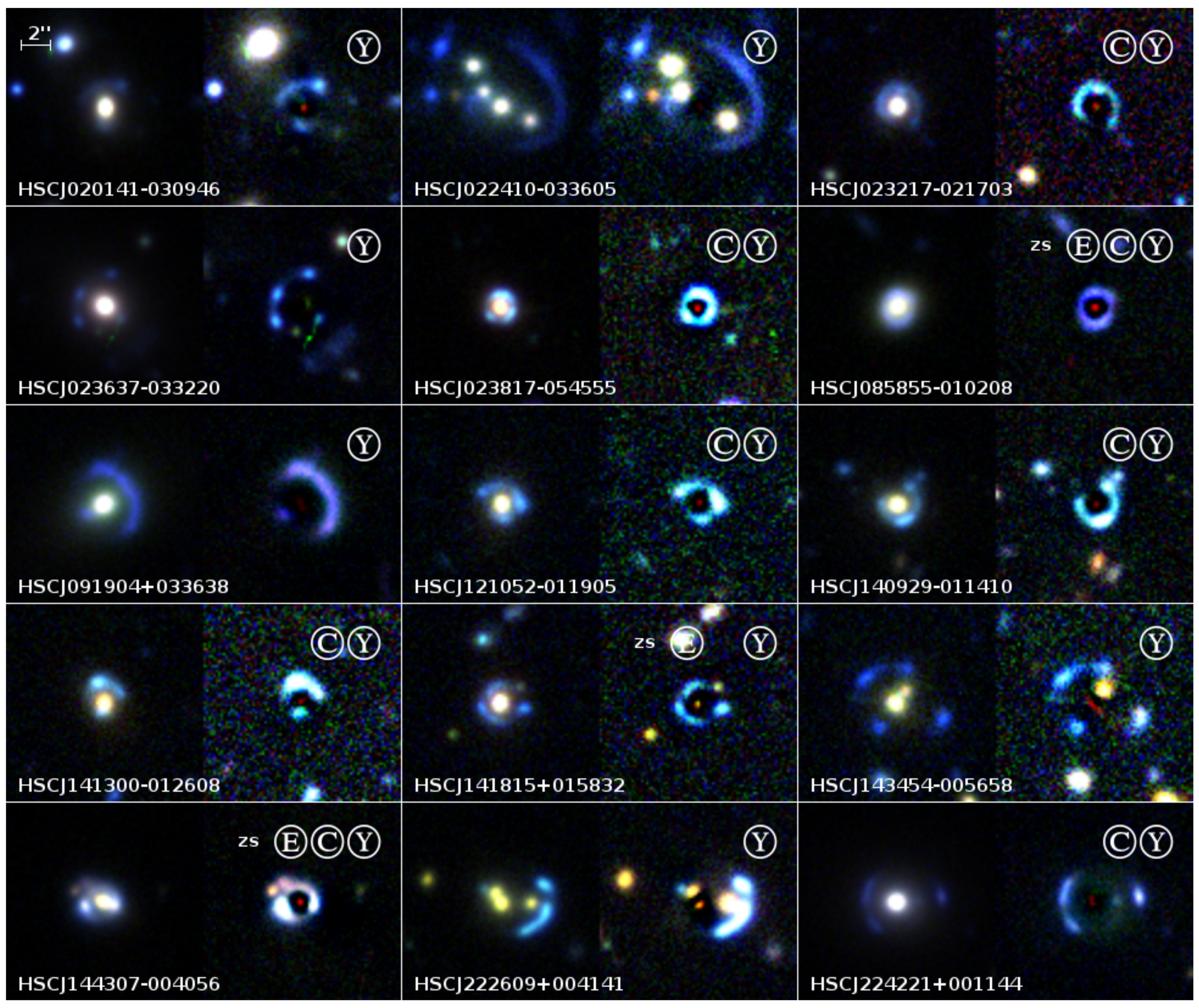
3. New lenses in the HSC survey

The Hyper Suprime-Cam (HSC), recently installed on Subaru, is currently surveying an area of 1400 square degrees of sky, with excellent image quality and great depth, ideal conditions for a lens search.

We used YattaLens, among with two other lens search algorithms, to look for lenses among 37,000 massive galaxies with BOSS spectroscopy in ~400 square degrees of imaging data from the HSC survey. We found:

- 15 grade A (definite) lenses
- 36 grade B (probable) lenses
- 282 grade C (possible) lenses

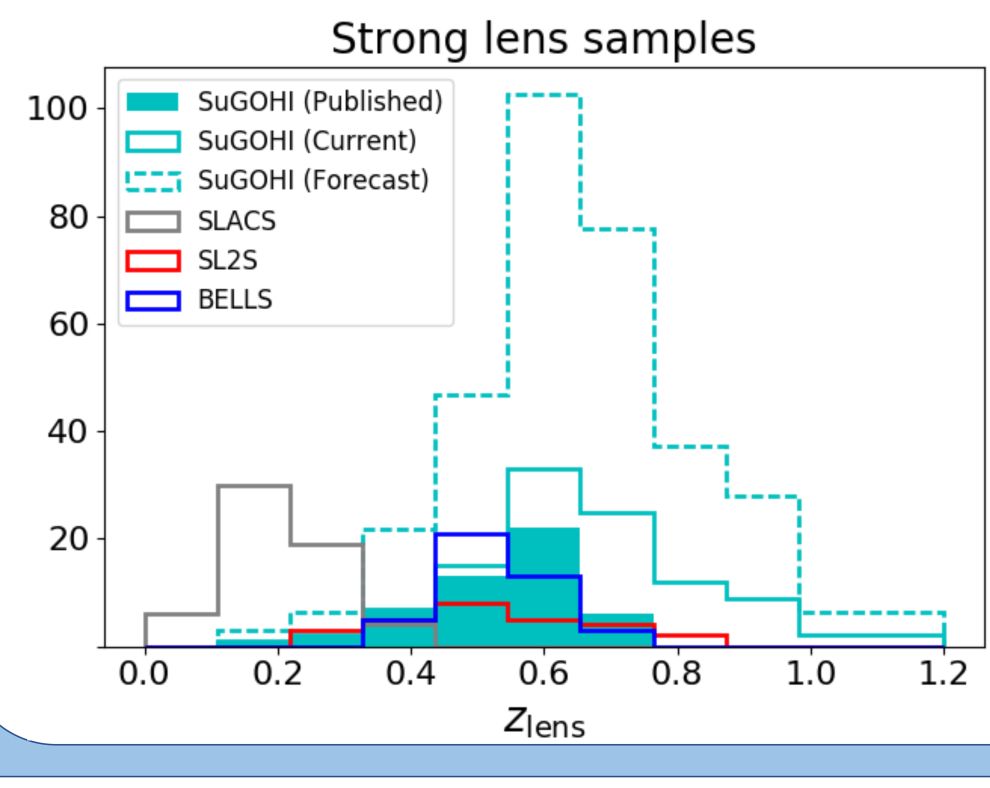
These lenses form the first sample of the Survey of Gravitationally-lensed Objects in HSC Imaging (**SuGOHI**)

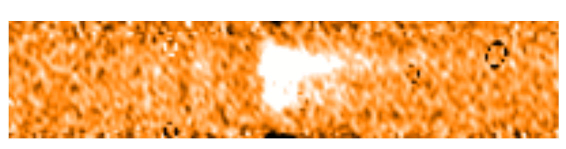


Newly discovered lenses from the first internal data release of the HSC survey (Sonnenfeld et al. 2017)

4. Future prospects

- Current size of SuGOHI sample: ~100 lenses
- By the end of HSC survey (2019): a few hundred. Will be **the largest sample of lenses from a single survey**.
- Ongoing spectroscopic follow-up with X-Shooter on VLT
- Will allow us to study the evolution in the inner structure of massive galaxies from z=1 to the present





Left: redshift distribution of lenses in the SuGOHI sample, compared to existing strong lens samples. *Bottom*: X-Shooter 2d spectrum of a doubly imaged Ly-alpha emission from a lensed source in the SuGOHI sample.

References: Sonnenfeld A., Chan H. J., Shu, Y., et al. 2017, PASJ in press, arXiv:1704.01585