Vera C. Rubin Observatory LSST - a multi-faceted game changer

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New Perspectives @ Fermilab
June 22, 2022

Heads up

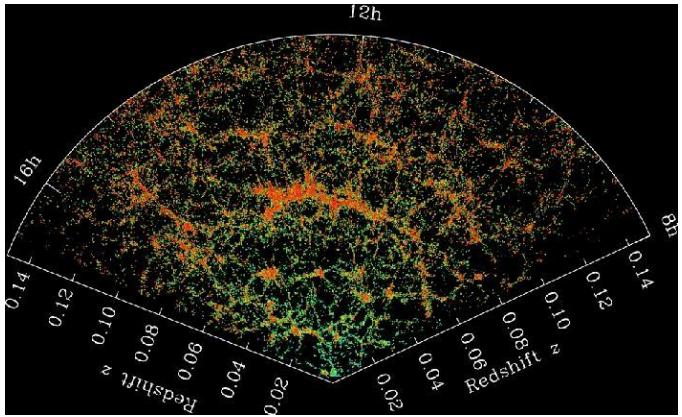
- ~Biased view coming up since I do something very specific
- Please speak up if I use jargon or if you have questions!

Background

Wide-surveys have demonstrated their power - probing cosmology and astrophysics. e.g.

- Sloan Digital Sky Survey
  - 2.5 meter telescope; operating since 2000
  - One of largest 3D map of galaxies

    (see more at https://www.sdss.org/)



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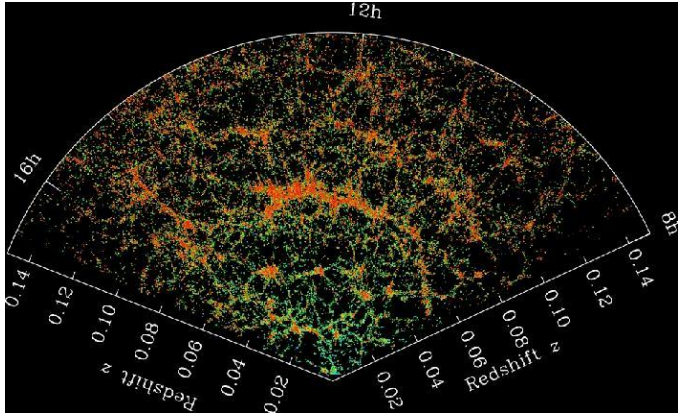

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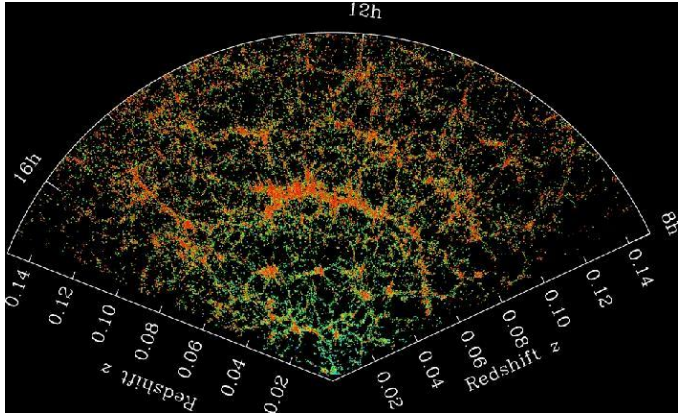


Sloan Digital Sky Survey

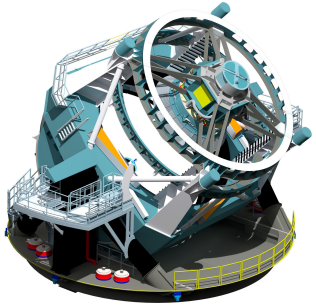
With advanced detectors and info technology, we can construct even bigger, more powerful telescopes – push to where statistics are not the limiting factor.

LSST

LSST = Legacy Survey of Space and Time

= survey done by Rubin Observatory

- 10-year, imaging survey
  - Photometric data: i.e. flux in different filters
- 3.2 Giga-pixel camera
  - 1500 HD TVs to display *one* image
- Petabyte of data
  - Will discover 10 billion galaxies in 2023-2033



Cerro Pachon, Chile

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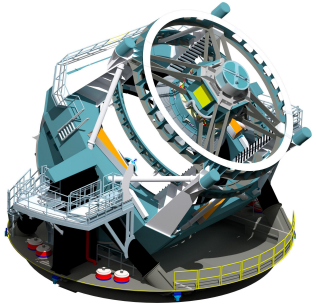

Cerro Pachon, Chile

Massive, effectively global project!

Tons of exciting challenges, from building the telescope to storing the data to doing science with it!

LSST - primary science goals

- Constraining Dark Energy and Dark Matter
- Survey of the Solar System
- Exploring the variable universe
- Mapping of the Milky Way

(See more at the LSST Science Requirements Document; LSST Science Book)

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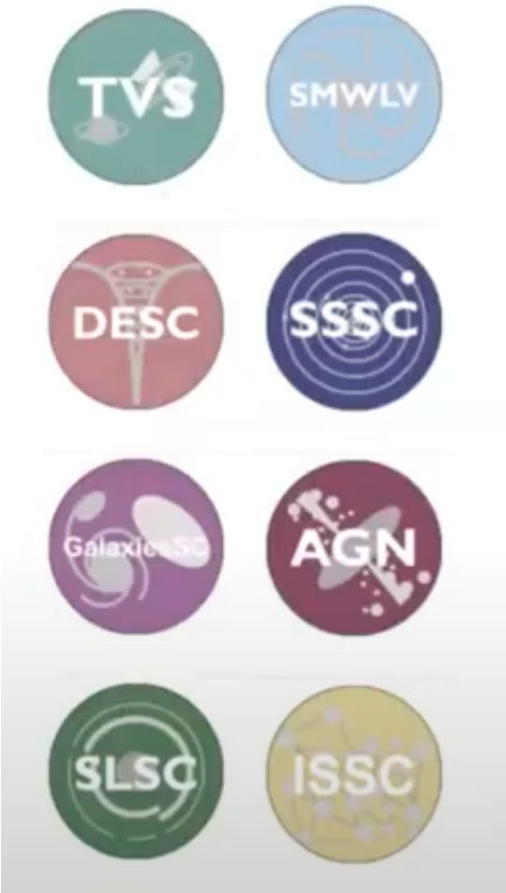
How does it all happen? **People (and organization)!**

LSST Science Collaborations

8 quasi-independent science collaborations

- Galaxies
- Stars, Milky Way, and Local Volume
- Solar System
- Dark Energy
- Active Galactic Nuclei
- Transient/variable stars
- Strong Lensing
- Informatics and Statistics



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Each one operates within its member-driven framework, with their own policies etc., preparing for a specific science case; all interact with the Project.

Find out more at

https://www.lsstcorporation.org/science-collaborations

Dark Energy Science Collaboration

1100+ members in 20+ countries, 47 published papers to date

Science focus: probing dark sector via

- Galaxy clustering - get statistical info re galaxy distribution and its evolution

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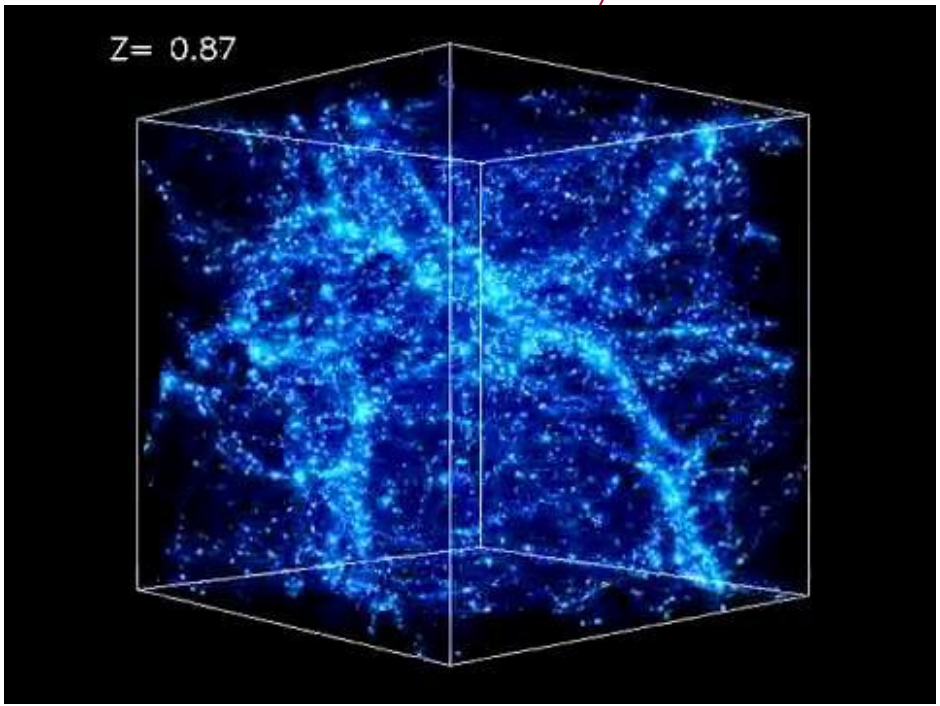

Simulations performed at the National Center for Supercomputer Simulations.
http://cosmicweb.uchicago.edu/filaments.html

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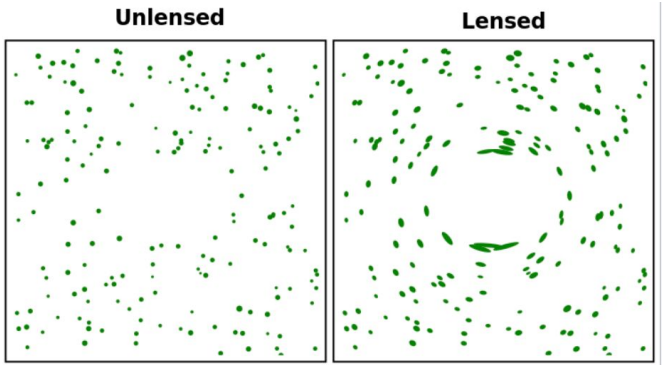
- Weak lensing - galaxy shape distortion due to gravitational lensing due to mass along the line of sight



Exaggerated example

https://en.wikipedia.org/wiki/Weak_gravitational_lensing

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- Weak lensing
- Galaxy clusters - most massive, virialized structures in the universe

Hubble image of Cluster Abell 1689
https://esahubble.org/images/heic1317a/

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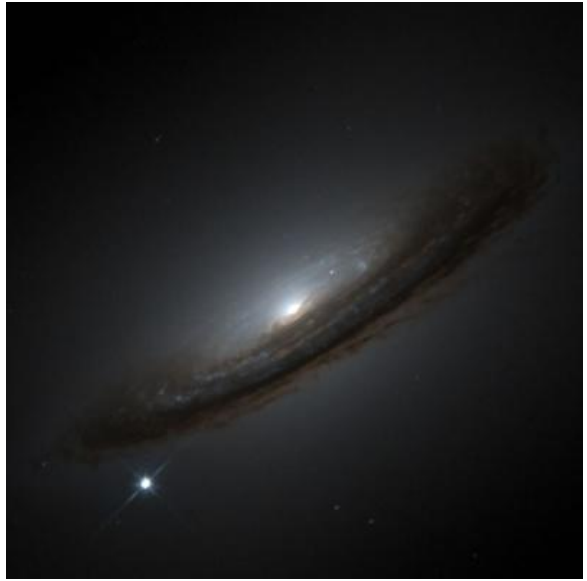
- Galaxy clusters
- Type Ia supernova - some of the brightest objects that are standardizable => standard candles



https://astronomy.swin.edu.au/cosmos/t/Type+Ia+Supernova

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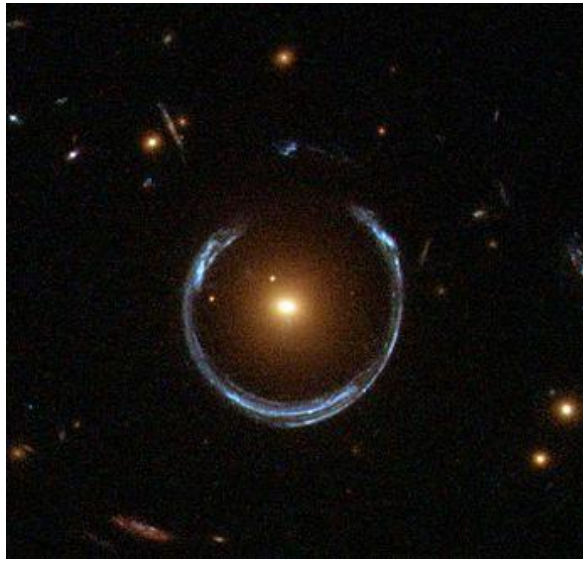
- Type Ia supernova
- Strong lensing - gravitational lensing that leads to multiple images of an object.



https://hubblesite.org/contents/articles/gravitational-lensing

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- .. (including gravitational wave sources, kilenovae, etc)

(See more at https://lsstdesc.org/)

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Exciting opportunities from pipeline development for single and joint probes to new scientific tools! (happy to talk about these in detail)

(See more at https://lsstdesc.org/)

More on opportunities via DESC

Science opportunities

- Projects one can lead; projects one can contribute to as a non-lead.
- Sprint projects offer an opportunity to test a project/topic out.
- DESC Seminars + Dark Energy School at collaboration meetings: range of topics to learn about.

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Service opportunities

- A way to give back to the collaboration but its self-rewarding!
- Learn SO many soft and technical skills.

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Visibility + Networking

- Easier to achieve visibility, e.g. within working groups.
- Interactions help figure out future collaborators, mentors/advisors, letter writers, etc.

LSST and DESC

As mentioned, DESC is just one of the collaborations within the Rubin Observatory framework.

Tons of opportunities within the larger Rubin community.

- Rubin Observatory Project and Community Workshops
  - Happens every year in August; travel grants generally available (when we can travel).
- LSST Data Science Fellowship Program (not just for LSST affiliated people!)

LSST is an exciting opportunity!

LSST is going to provide us unprecedented amounts of data

- Opportunity to do precision science, pave way for discovery, work on new developments in general, and so on

Large collaborations provide an incredible wealth of opportunities to grow (as a scientist and as an individual).

- Big Data science is changing the game. A lot of things now matter more (IMO):
  - Ability to collaborate (note: independent work is still important!).
  - Service/infrastructure work.
  - Versioning! Documentation! Learning about new things.
- Opportunities to develop skills that marketable in academia and beyond
  - Large collaborations ➔ more people to talk to ➔ more potential mentors and advisors.

Thanks!