

Cosmos Key Program (KP5)

From the OzGrav-2 proposal, KP5 aims to:

“Determine fundamental properties of the Universe”

The three themes of the Cosmos Key Program are:

Cosmology
with Standard
Sirens

Astrophysics of
Gravitational
Wave sources

Cosmology
with Fast
Radio Bursts

Your CIs and Program Scientists for KP5

Chris Blake
(CI)



Ilya Mandel
(CI)



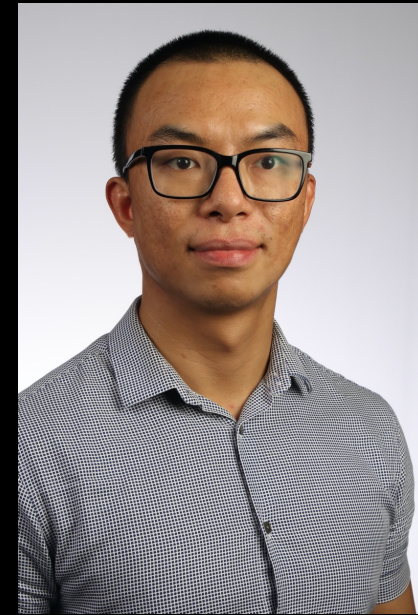
Nandita Khetan
(Standard Sirens PS)



Manisha Caleb
(FRBs PS)



Robert Song
(Astrophysics PS)



Please get in touch with any of us if you have questions about our Key Program or would like to discuss where your work fits in!

Standard sirens and the Hubble tension

Local
measurements
of the cosmic
expansion rate



Early-Universe
predictions



Standard
sirens!

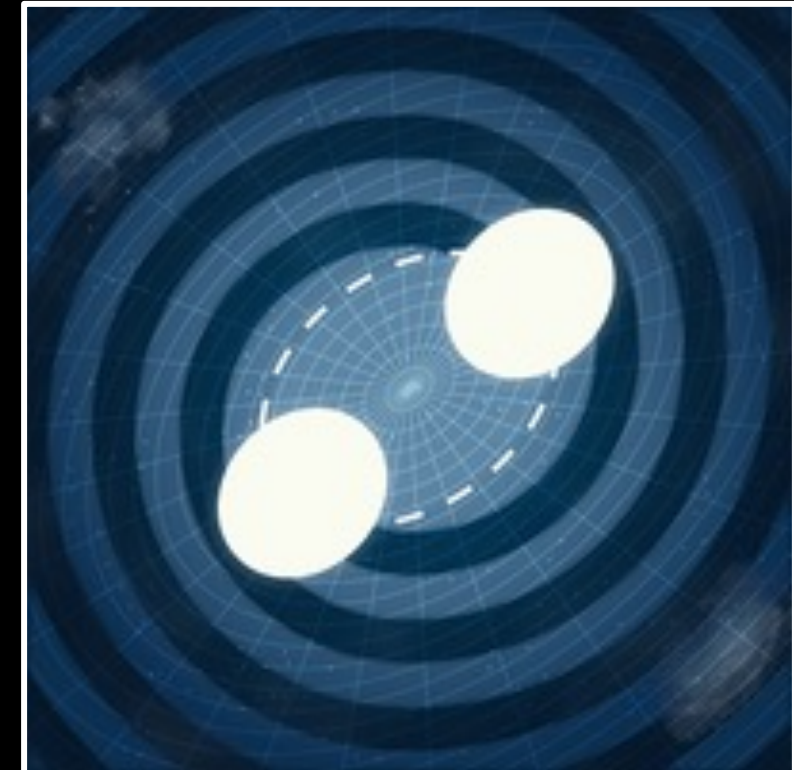
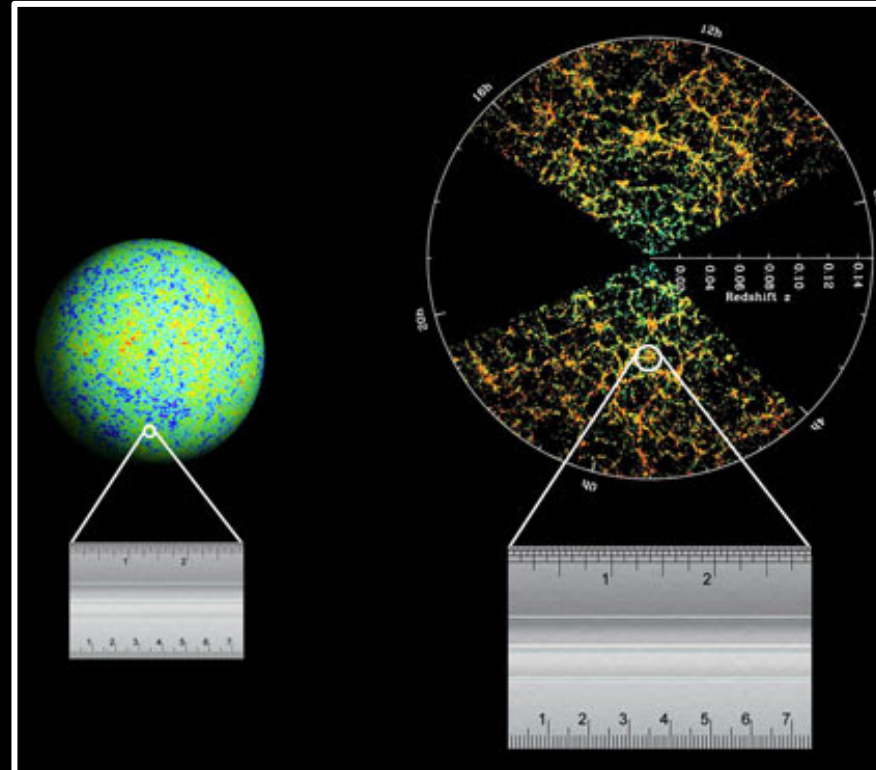


Inside the toolbox of cosmologists for mapping out the Universe ...

Standard candles

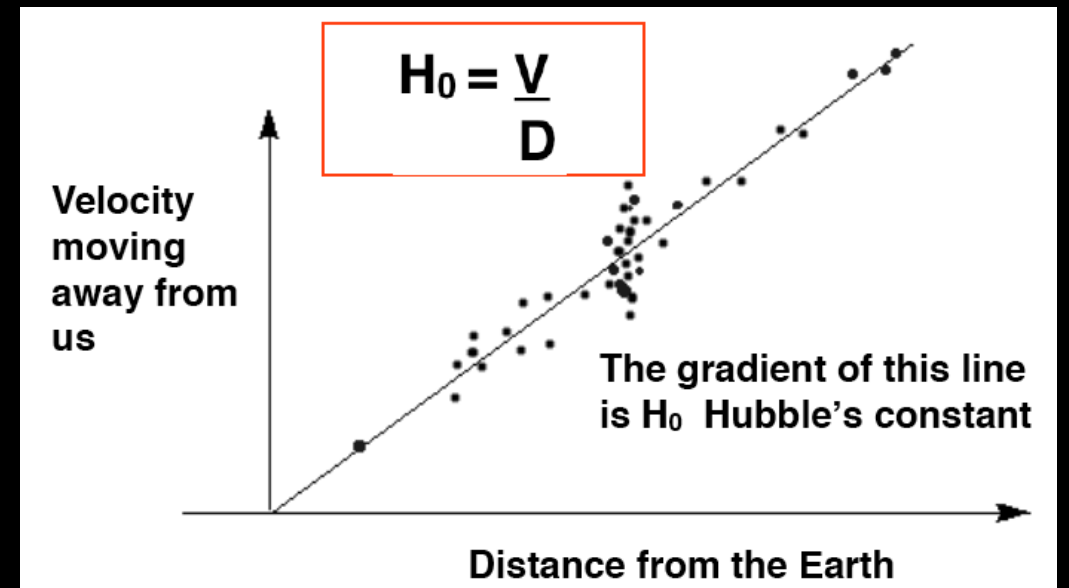
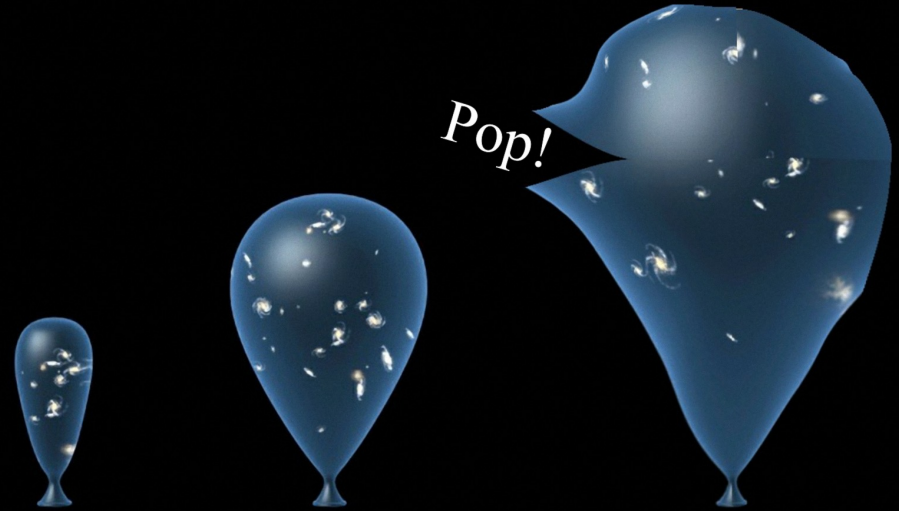
Standard rulers

Standard sirens



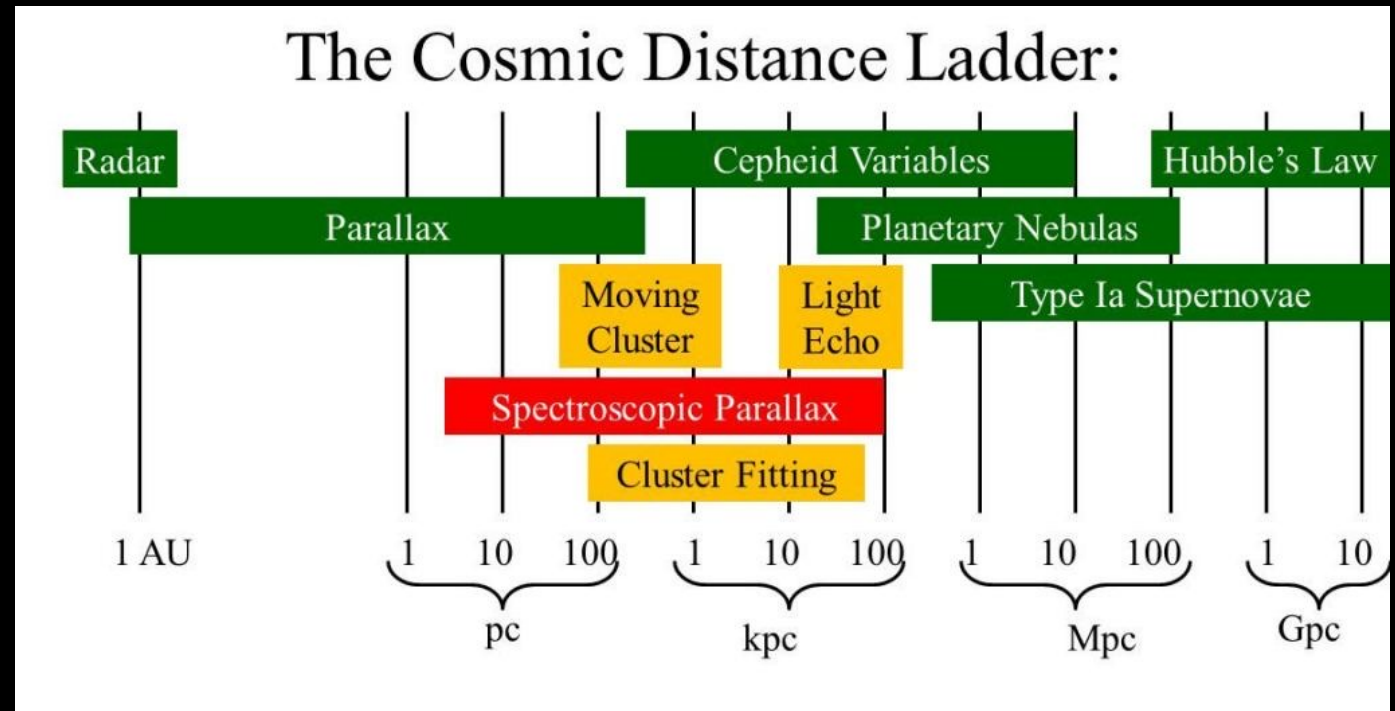
What is H_0 ? Why do we care?

- H_0 is “Hubble’s constant”, the oldest cosmological parameter 😊
- H_0 is today’s cosmic expansion rate (its value changes with time!)
- H_0 sets the **age of the Universe** ($T_{\text{age}} \sim 1/H_0$)
- H_0 sets the **distance-redshift relation** ($D \sim cz/H_0$)



How do supernovae measure H_0 ?

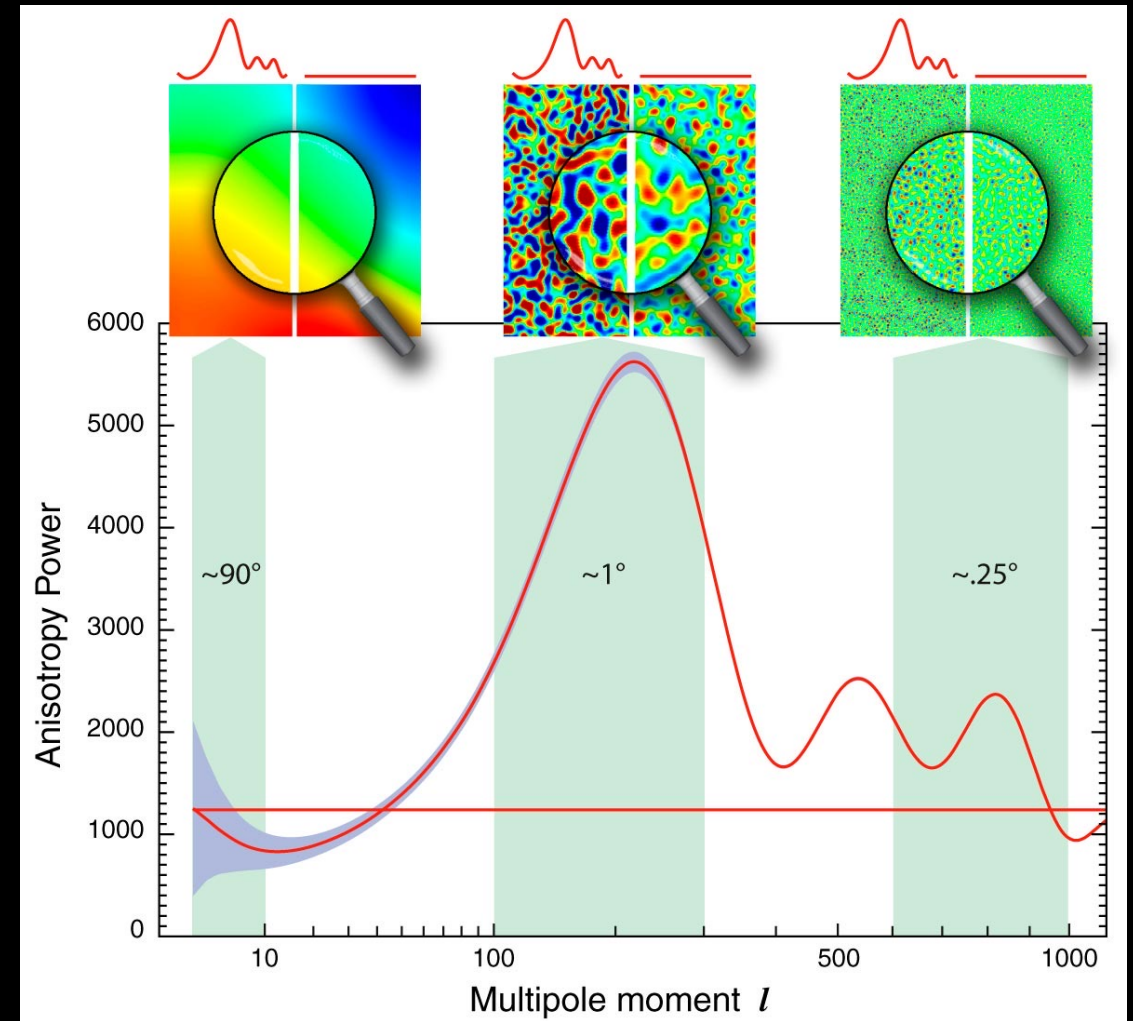
- Type Ia supernovae are a **standard candle**, but we don't know the absolute brightness
- Supernovae can determine H_0 in the context of a **distance ladder**
- Calibration by Cepheids and geometric anchors



$$H_0 = 73.0 \pm 1.0 \text{ km s}^{-1} \text{ Mpc}^{-1} \quad (\text{Riess et al. 2022, SNe + distance ladder})$$

How does the Cosmic Microwave Background measure H_0 ?

- The CMB does not “measure” H_0 – it’s one of many parameters fit to the CMB power spectrum
- Hence, the CMB predicts H_0 **within a cosmological model**
- H_0 affects the distance to the CMB redshift, hence controls its angular appearance (this is a **standard ruler**)



$$H_0 = 67.5 \pm 0.5 \text{ km s}^{-1} \text{ Mpc}^{-1} \quad (\text{Planck satellite, standard } \Lambda\text{CDM model})$$

Supernova and CMB determinations of H_0 currently disagree at the $\sim 5\sigma$ level!

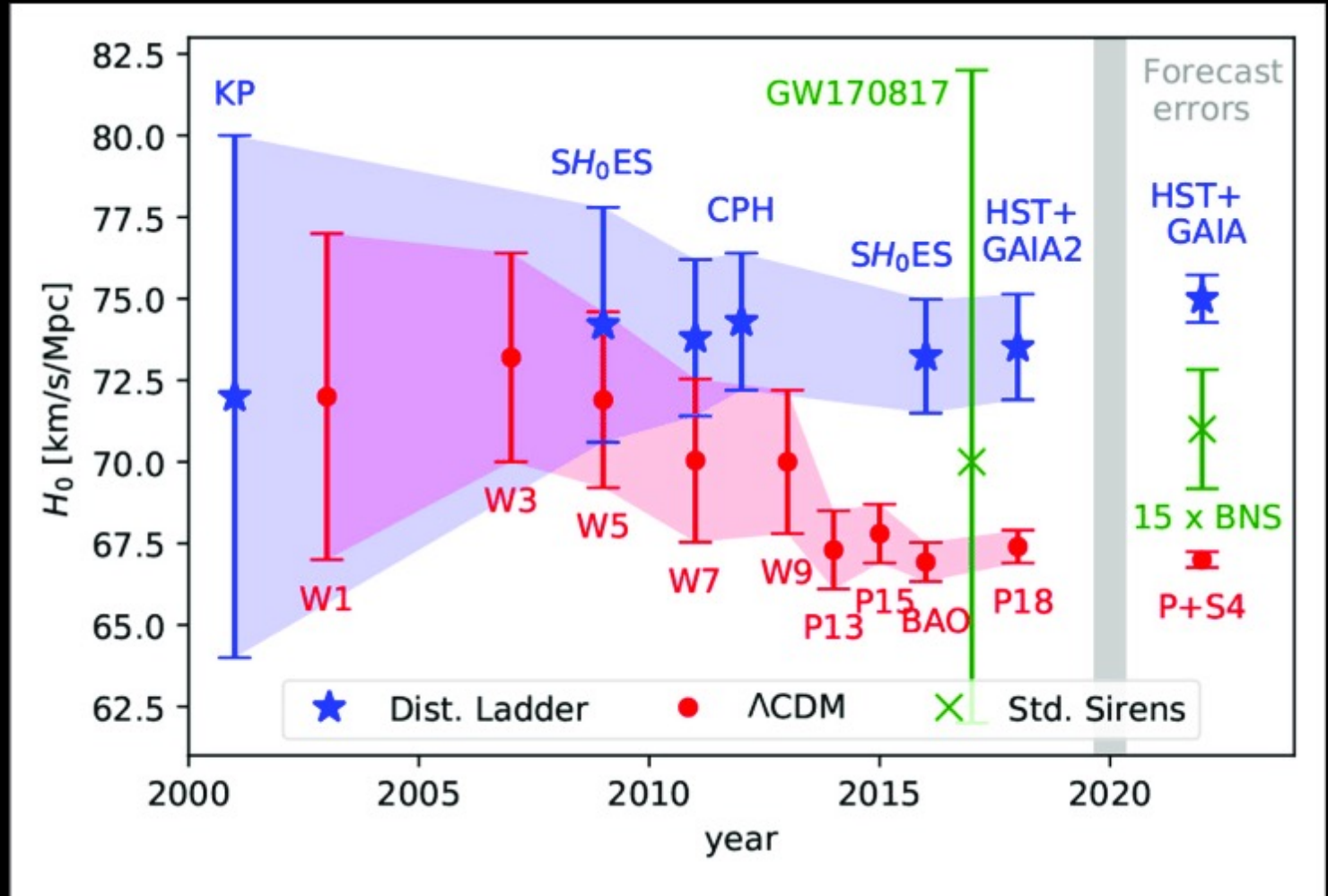
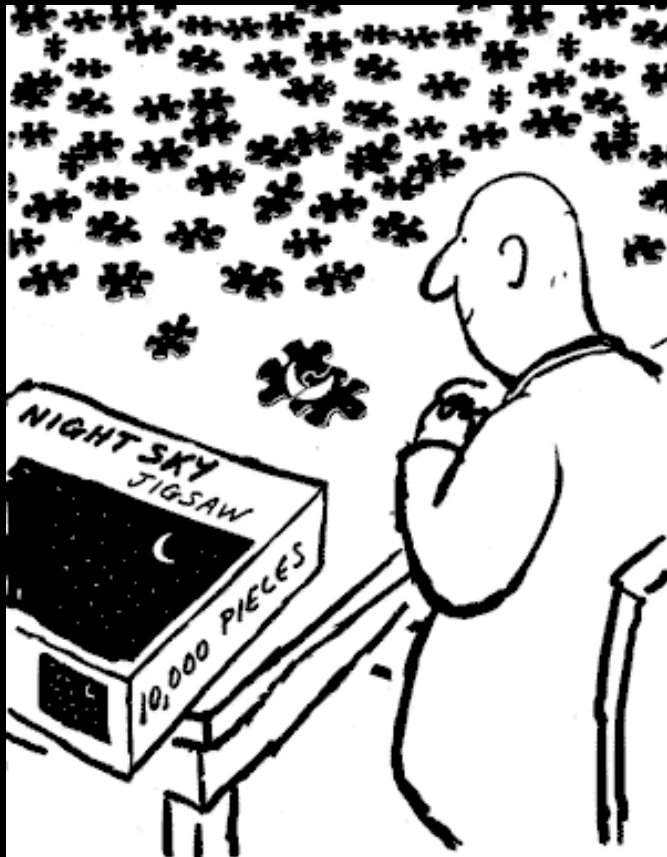


Figure from: Ezquiaga & Zumalacarregui (2018)

How do standard sirens measure H_0 ?

- Standard sirens directly measure the luminosity distance – no need for a distance ladder!
- **Bright sirens**: redshift from an optical counterpart ($D \sim cz/H_0$)
- **Dark sirens**: statistical weighting over a host galaxy catalogue

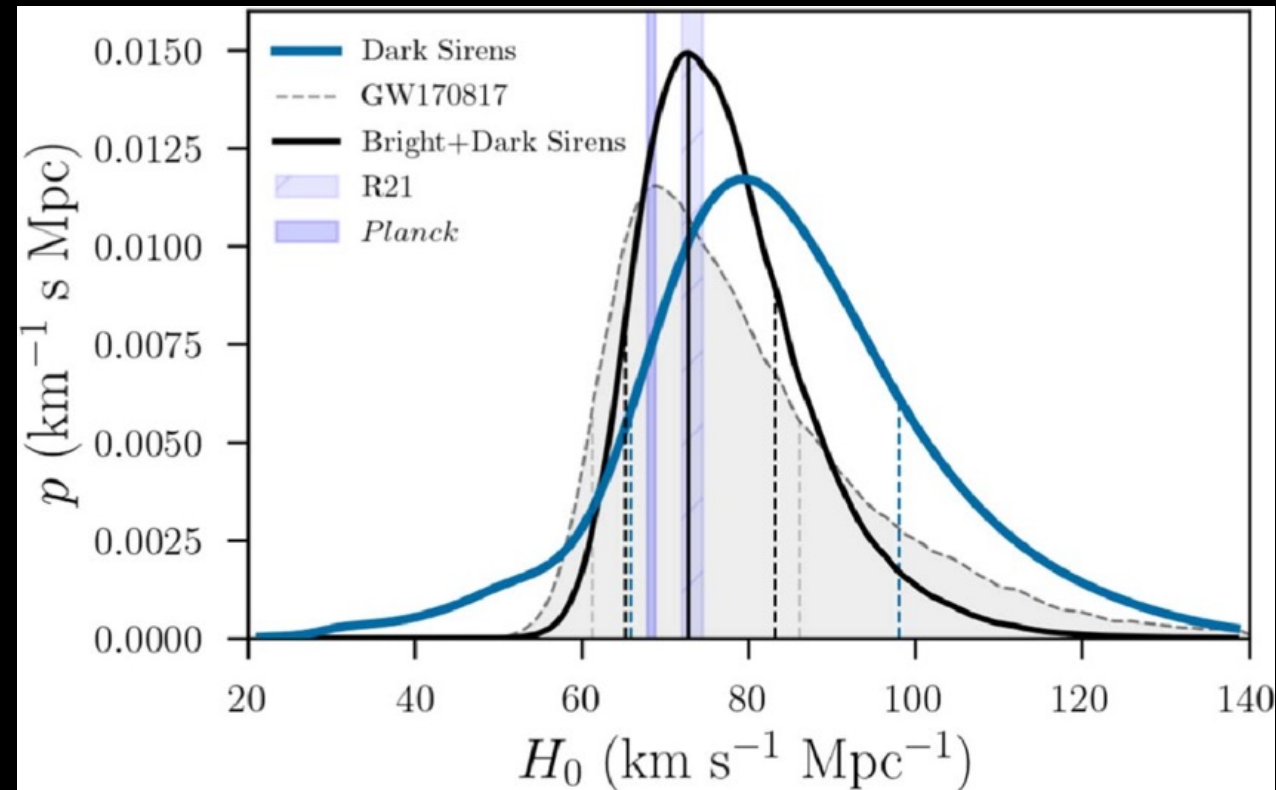


Figure from: Palmese et al. (2023)

Forecasts say we need ~ 50 bright sirens and ~ 1000 low- z dark sirens for a $\sim 2\%$ H_0 measurement!

What is our OzGrav team doing?

Effect of galaxy peculiar velocities

Ryan, Khaled, Simon

Improved galaxy catalogues for dark sirens

Cullan, Liana, Chris L

Simulation-based population studies

Liana, Cullan, Nandita

Improving inclination angles

Kelly, Adam

Improved forecasts and dark siren methods

Maddy, Nandita, Cullan

Spectral sirens and neutron star equation of state

Hui, Eric, Spencer, Paul

How can you get involved?

- We use the **#h0-project** channel on the OzGrav Slack
- We maintain a **standard sirens project list** linked from #h0-project
- We hold **monthly standard siren videocons** including project updates, short talks, journal clubs, etc. – second Thursday in the month at 2pm AEDT
- All are welcome to join our team!

