6. Discrepancy Between Theoretically Estimated & Actual Value of Λ

A theoretical calculation of the cosmological constant based on a mechanical model of vacuum,
Xiao-Song Wang, https://arxiv.org/pdf/2209.10525

In 1917, A. Einstein thought that his equations of gravitational fields should be revised to be

$$R_{\mu v} - \frac{1}{2} g_{\mu v} R + \Lambda g_{\mu v} = -\kappa T^{\mathrm{m}}_{\mu v},$$

where $g_{\mu v}$ is the metric tensor of a Riemannian spacetime, $R_{\mu v}$ is the Ricci tensor, $R \equiv g_{\mu v} R\mu_{v}$ is the scalar curvature, $g_{\mu v}$ is the contravariant metric tensor, k is Einstein's gravitational constant, is the energy-momentum tensor of a matter system, Λ is the cosmological constant.

The cosmological constant is a measure of the energy density of the vacuum, which is the lowest energy state.

Theoretical Estimate of Λ

A "natural" Planck system of units expresses everything as combination of fundamental physical constants;
the Planck density is:

$$\rho_{planck} := \frac{2\pi \cdot c^5}{\hbar \cdot G^2} \qquad \rho_{planck} = 5.169 \times 10^{96} \frac{kg}{m^3}$$

The observed value is:

$$\Omega_{vac} := 0.7 \qquad \rho_{crit} := \rho_0$$

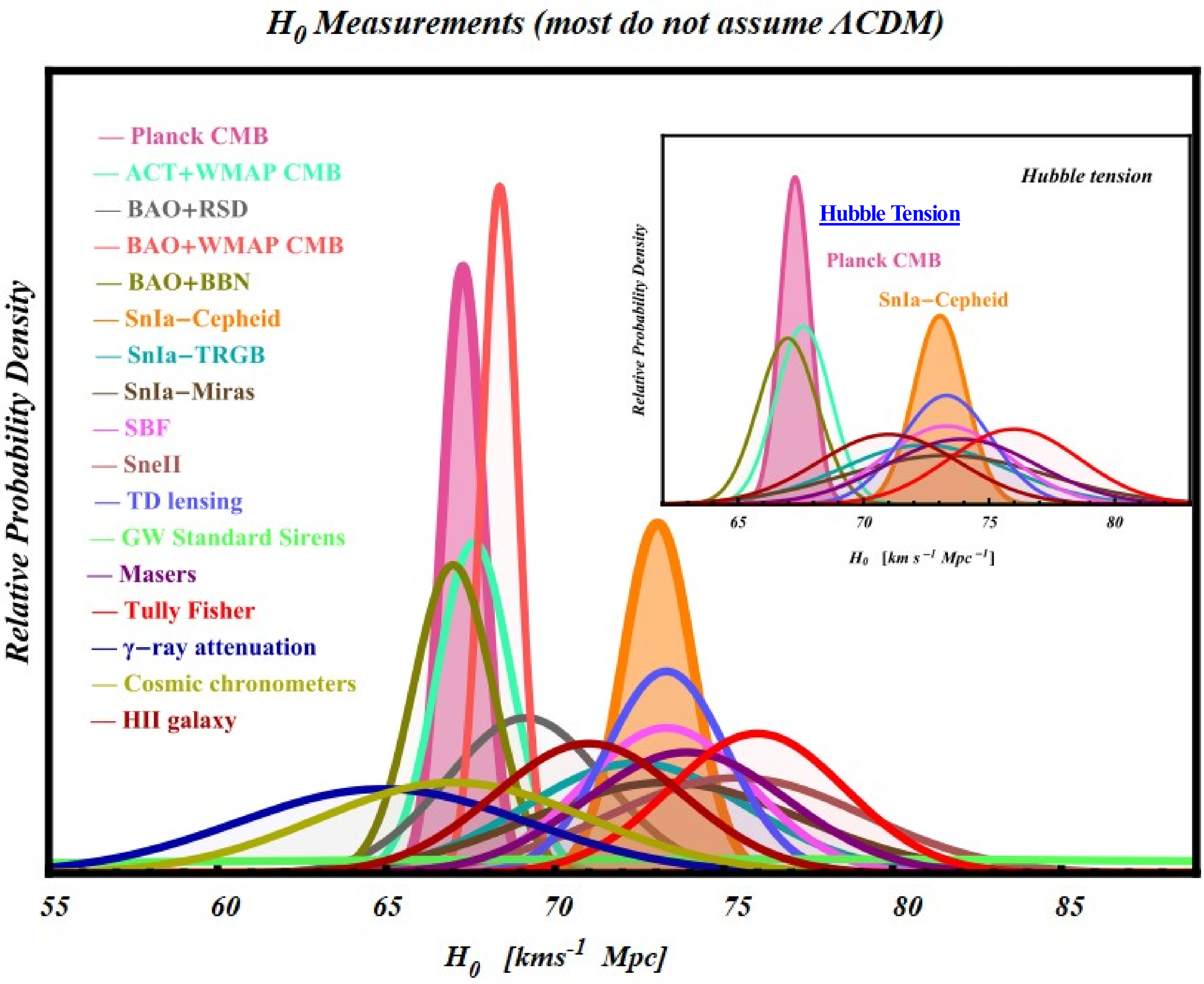
$$\rho_{vac} := \Omega_{vac} \cdot \rho_{crit} \qquad \rho_{vac} = 6.051 \cdot 10^{-30} \cdot \frac{gm}{cm^3}$$

This is Off by 123 Orders of Magnitude

- This is modestly called "**the fine-tuning problem**"
  (because it requires a cancellation to 1 part in 10^{123})
- The other "natural" value is zero
- So, lacking a proper theory, physicists just declared the cosmological constant to be zero, and went on…

7. The Hubble H_0 CMBR versus ΛCDM Tension

Challenges for ΛCDM: An update, L. Perivolaropoulos and F. Skara, arXiv:2105.05208v3 [astro-ph.CO]
April 7, 2022



One dimensional relative probability density value of H_0 derived by recent measurements

Notice that the tension is not so much between early and late time approaches but more between approaches that calibrate based on low z (z 0.01) gravitational physics and those that are independent of this assumption.

For example cosmic chronometers and γ-ray attenuation which are late time but independent of late gravitational physics are more consistent with the CMB-BAO than with late time calibrators.

Data Sources: (Planck CMB (Aghanim et al. 2020e), ACT+WMAP CMB (Aiola et al. 2020), BAO+RSD (Wang et al. 2017), BAO+WMAP CMB (Zhang and Huang 2019), BAO+BBN (Addison et al. 2018), SnIa-Cepheid (Riess et al. 2021b), SnIa-TRGB (Jones et al. 2022), SnIa-Miras (Huang et al. 2019), SBF (Blakeslee et al. 2021), SneII (de Jaeger et al. 2022), TD lensing (Wong et al. 2020), GW Standard Sirens (Abbott et al. 2020a), Masers (Pesce et al. 2020), Tully Fisher (Kourkchi et al. 2020), γ-ray attenuation (Zeng and Yan 2019), cosmic chronometers (Yu et al. 2018), HII galaxy (Fern´andez Arenas et al. 2018)). All measurements are shown as Normalized **Gaussian** Cistributions.