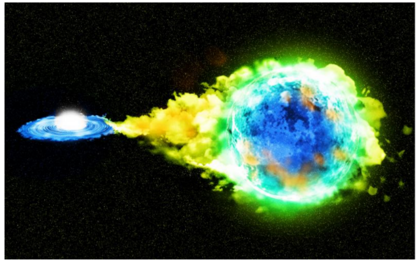
Hubble constant using SNIa



https://www.ipmu.jp/en/20180921-WhiteDwarf

- **Supernovae of Type Ia** have a fairly consistent peak luminosity
  → can be used as "**standard candles**" (apparent magnitude yields distance)

- Measure redshift of host galaxy to infer the *expansion history* of the Universe since the light of the SN was emitted

luminosity distance

$$D_L = (1+z)\, r(z)$$

comoving distance

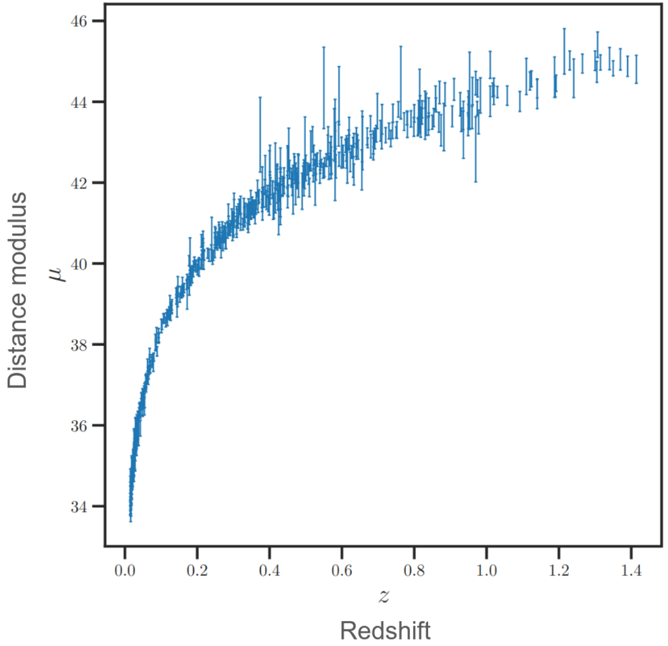
$$r(z) = \begin{cases} \frac{1}{\sqrt{\Omega_k}} \sinh\left(\sqrt{\Omega_k}\, \chi(z)\right), & \Omega_k > 0 \,(\text{open universe}) \\ \chi(z), & \Omega_k = 0 \,(\text{flat universe}) \\ \frac{1}{\sqrt{|\Omega_k|}} \sin\left(\sqrt{|\Omega_k|}\, \chi(z)\right), & \Omega_k < 0 \,(\text{closed universe}) \end{cases}$$

$$\chi(z) = \int_0^z \frac{c\, dz'}{H(z')}$$

ΛCDM

$$H(z) = \underline{H_0} \sqrt{\underline{\Omega_m}(1+z)^3 + \underline{\Omega_k}(1+z)^2 + \underline{\Omega_\Lambda}}$$

Hubble parameter



→ provides information on cosmological parameters

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- **Goal:** infer *cosmological parameters* from *Supernovae Ia measurements*

- **Data:** for a start, we recommend using the *Pantheon* dataset https://github.com/PantheonPlusSH0ES/DataRelease (containing 1701 supernova measurements)

- **Methods:**
  - Probabilistic programming (e.g. using NumPyro) or
  - Simulation-based inference (e.g. using sbi)

- **Proposed simplifications:** you can start by assuming that all the datapoints are independent. Once you have built a working method, you can try to make it more realistic, e.g. by taking into account the covariance matrix provided by the Pantheon collaboration, etc.

- **References:**
  - Pantheon+ paper https://arxiv.org/abs/2112.03863
  - Shoes paper https://arxiv.org/abs/2112.04510
  - and references therein