

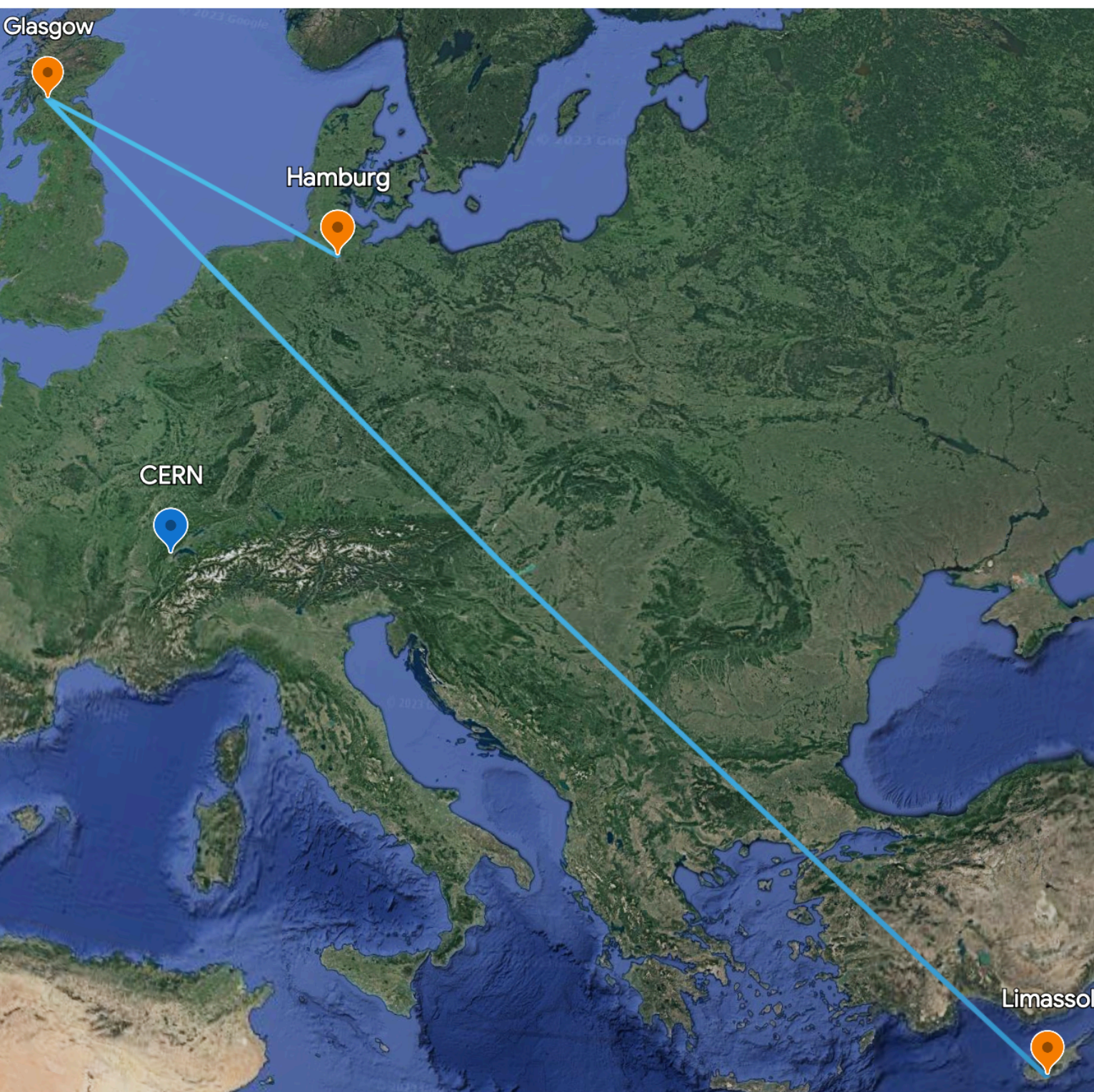
# Neural Networks for BSM searches

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Panagiotis Stylianou  
(DESY Theory Group)



FH Fellow Meeting | 28 April 2023

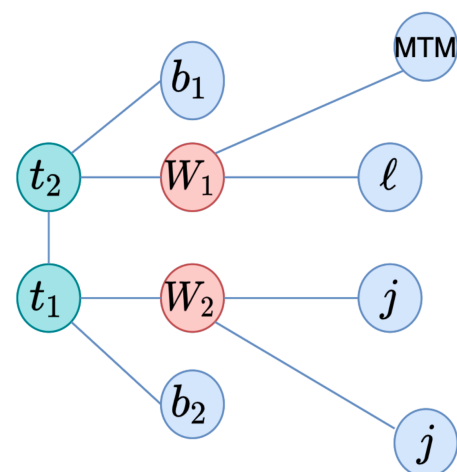
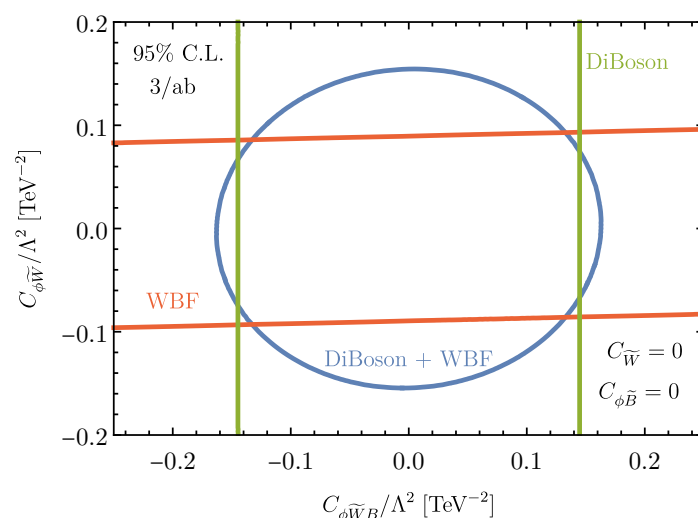


- Born and raised in Limassol, Cyprus
- **‘Integrated Masters’** in University of Glasgow
- **Summer internships:**
  - Glasgow: ‘Optimising combinatorics in multi-body final states in LHCb’
  - CERN: ‘Electroweak production cross sections of charm and bottom’
- **PhD in Glasgow:**
  - CP violation in gauge-Higgs interactions
  - Asymmetric scalar decays: interference and improvements with Recurrent Neural Networks
  - Improving bounds on Wilson Coefficients using Graph Neural Networks



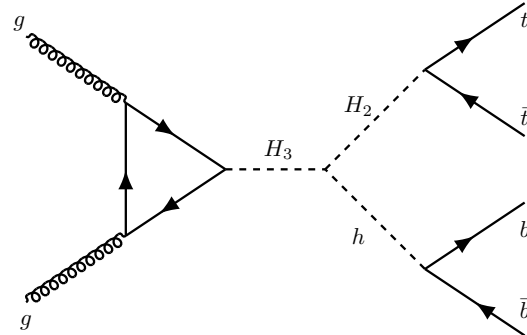
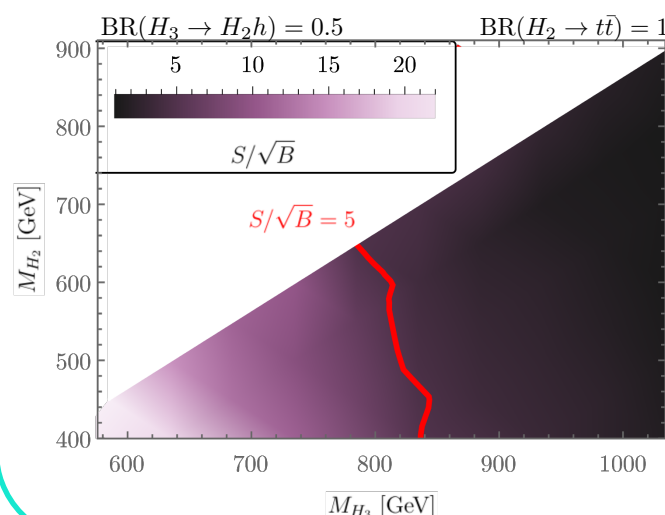
# My path

$$\begin{aligned}\mathcal{O}_{\widetilde{W}} &= \epsilon^{abc} \widetilde{W}_{\mu\nu}^a W^{b\nu\rho} W^{c\rho\mu} \\ \mathcal{O}_{\phi\widetilde{W}B} &= (\Phi^\dagger \tau^a \Phi) \widetilde{W}_{\mu\nu}^a B^{\mu\nu} \\ \mathcal{O}_{\phi\widetilde{B}} &= \Phi^\dagger \Phi \widetilde{B}_{\mu\nu} B^{a\mu\nu} \\ \mathcal{O}_{\phi\widetilde{W}} &= \Phi^\dagger \Phi \widetilde{W}_{\mu\nu}^a W^{a\mu\nu}\end{aligned}$$



Physics-inspired graphs and GNN → bounds on:

$$\begin{aligned}&\mathcal{O}_G, \mathcal{O}_{\phi q}^{(3)33}, \mathcal{O}_{uG}^{33}, \mathcal{O}_{uW}^{33}, \\&\mathcal{O}_{qq}^{(1)i33i}, \mathcal{O}_{qq}^{(3)i33i}, \mathcal{O}_{qq}^{(3)ii33}, \\&\mathcal{O}_{qu}^{(8)ii33}, \mathcal{O}_{ud}^{(8)33ii}, \mathcal{O}_{uu}^{i33i}, \\&\mathcal{O}_{lq}^{(3)ii33}\end{aligned}$$

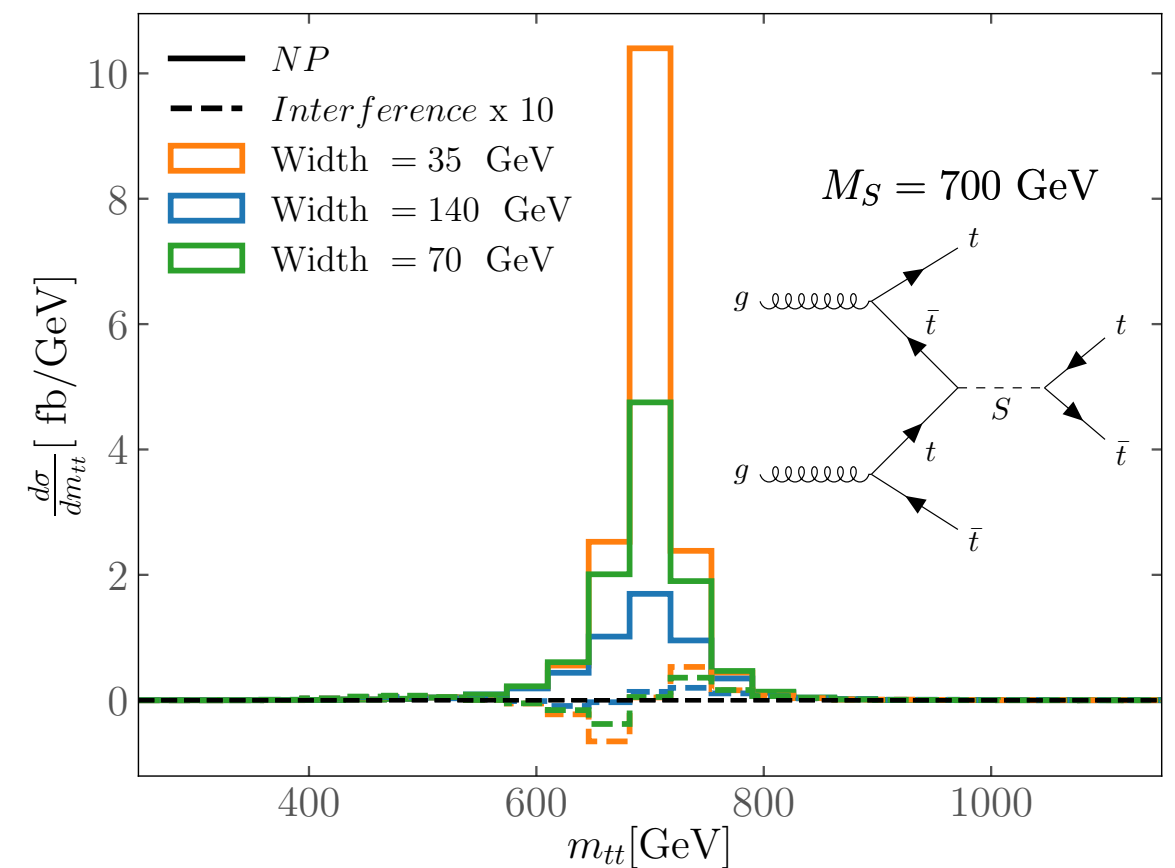


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# Current work

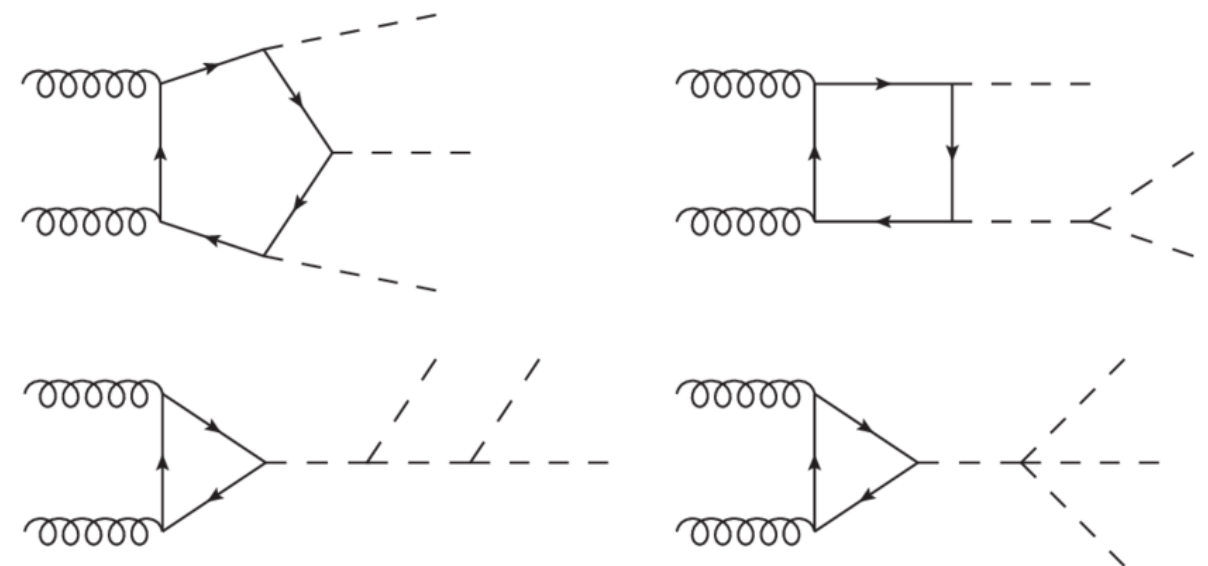
- **Four-tops:**

- ▶ Recent evidence by ATLAS & CMS, avoids signal-background interference of top pair production
- ▶ Complex process, but ML can exploit the plethora of kinematic information → potential to constrain BSM physics
- ▶ Signal-signal interference in the presence of multiple scalars?



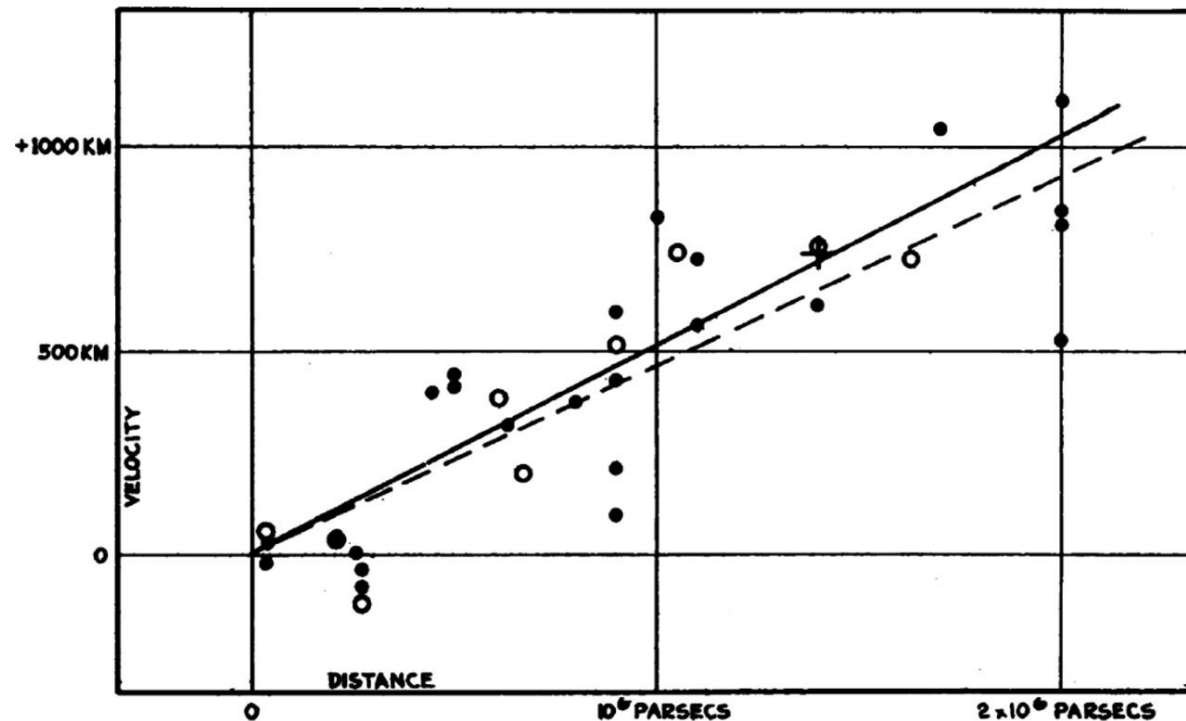
- **Triple-Higgs:**

- ▶ Access to the quartic Higgs coupling  $\kappa_4$
- ▶ Extremely small cross sections even for large  $\kappa_4$  and very complex final state
- ▶ Can physics-inspired graph embeddings give any valuable bounds on  $\kappa_4$  already at HL-LHC (e.g. compared to unitarity)?



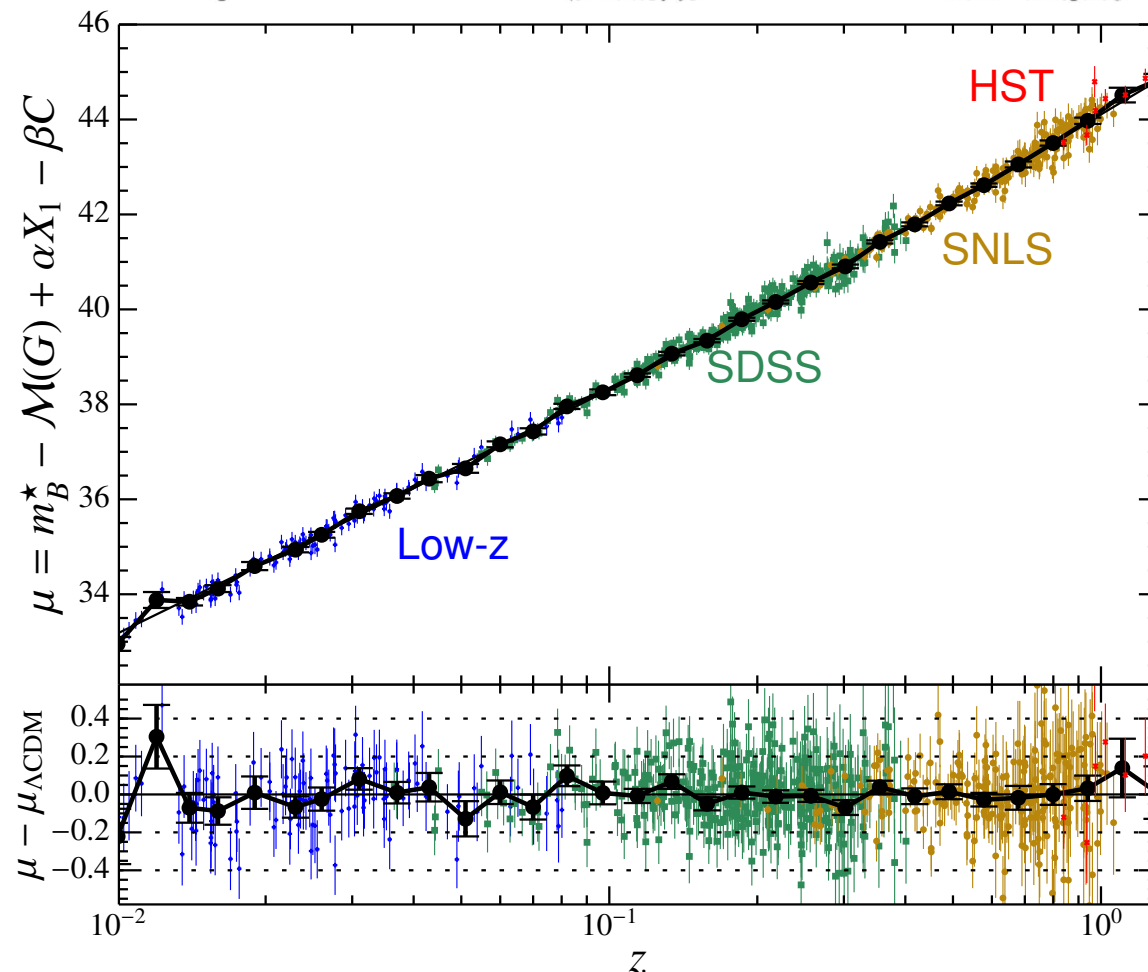
# A plot that impressed me

Velocity-Distance Relation among Extra-Galactic Nebulae.



**Hubble's law:** galaxies are receding away from us, observed in 1929

→ expansion of the Universe



**Modern version from supernovae:**

- distances orders of magnitude greater than Hubble's plot
- still unknown what drives the expansion