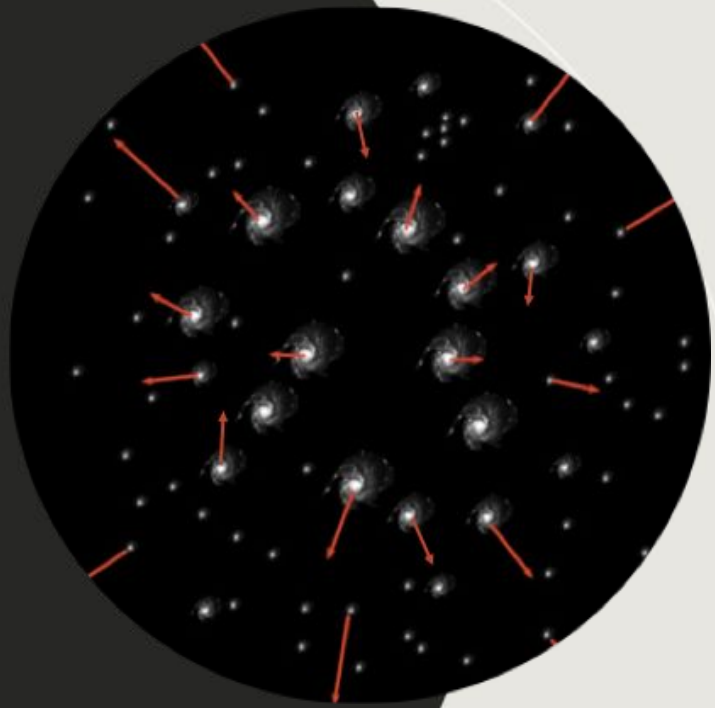
Constraining Cosmology with Galaxy Peculiar Velocities Using Supernova Type Ia



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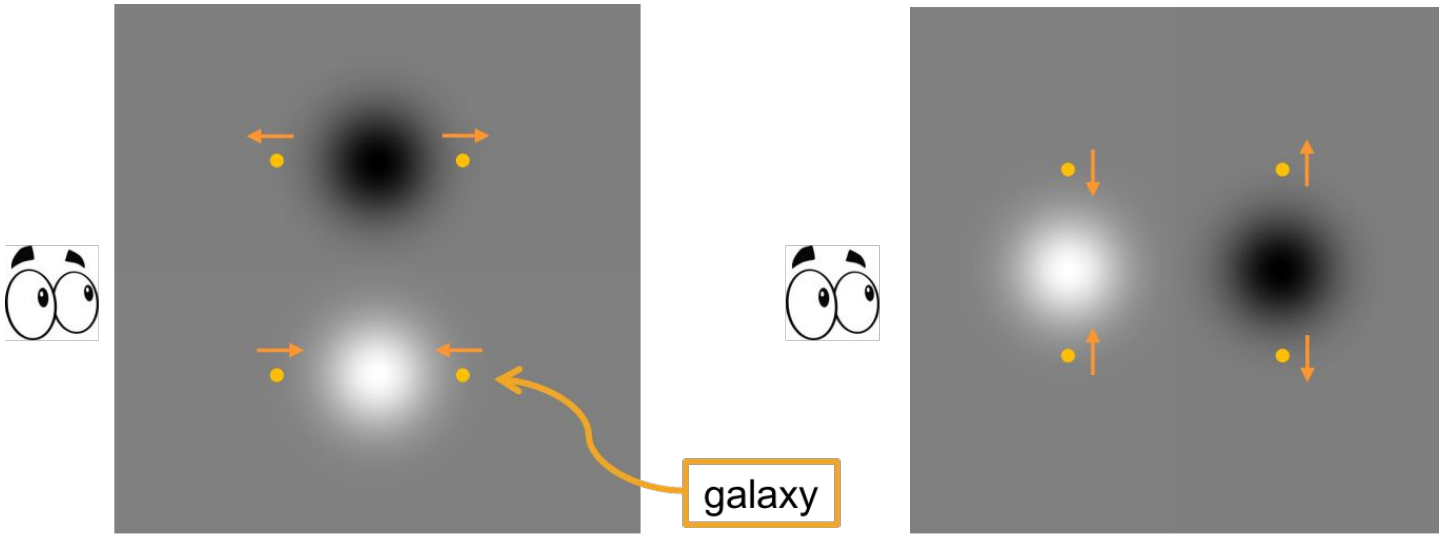
What is Peculiar Velocity?



$$V_{\text{pairwise}} \neq 0$$

$$V_{\text{pairwise}} = 0$$

What is Peculiar Velocity?

$$v(r,a) = -\frac{2}{3} H(a) a f b_{\rm gal}(a) \frac{r\bar{\xi}^{\rm dm}(r,a)}{1+\xi^{\rm gal}(r,a)}$$

What is Peculiar Velocity?

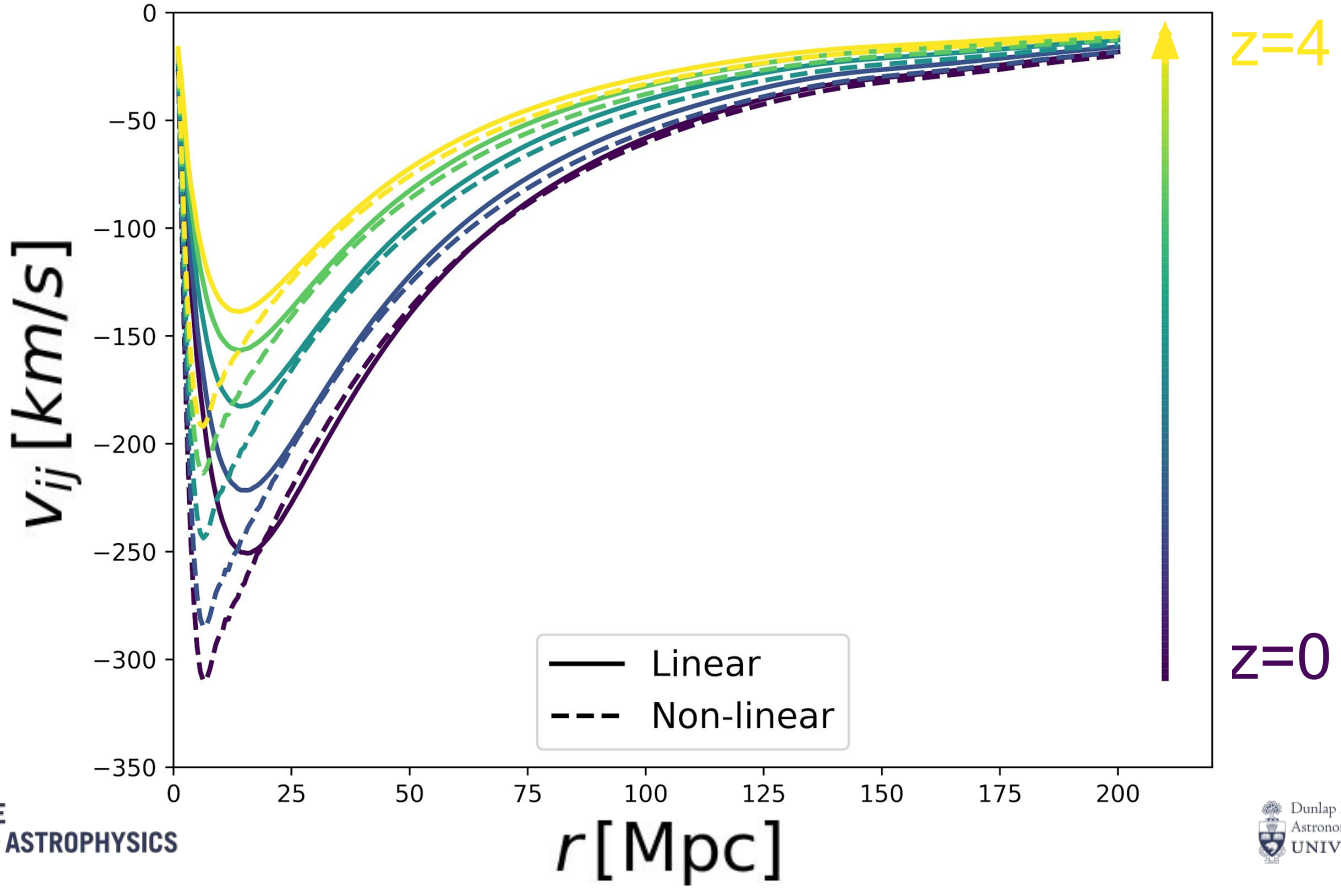
$$v(r,a) = -\frac{2}{3} H(a) a f b_{\rm gal}(a) \frac{r\bar{\xi}^{\rm dm}(r,a)}{1+\xi^{\rm gal}(r,a)}$$

$$f \equiv \frac{d\ln D_a}{d\ln a} \approx \Omega_m^\gamma$$

Growth of Structure

$$\gamma = 0.55 \text{ when } \Omega_m + \Omega_\Lambda = 1$$

Theory Pairwise Velocity



Need to measure data

Current data is not enough for this

Need LSST

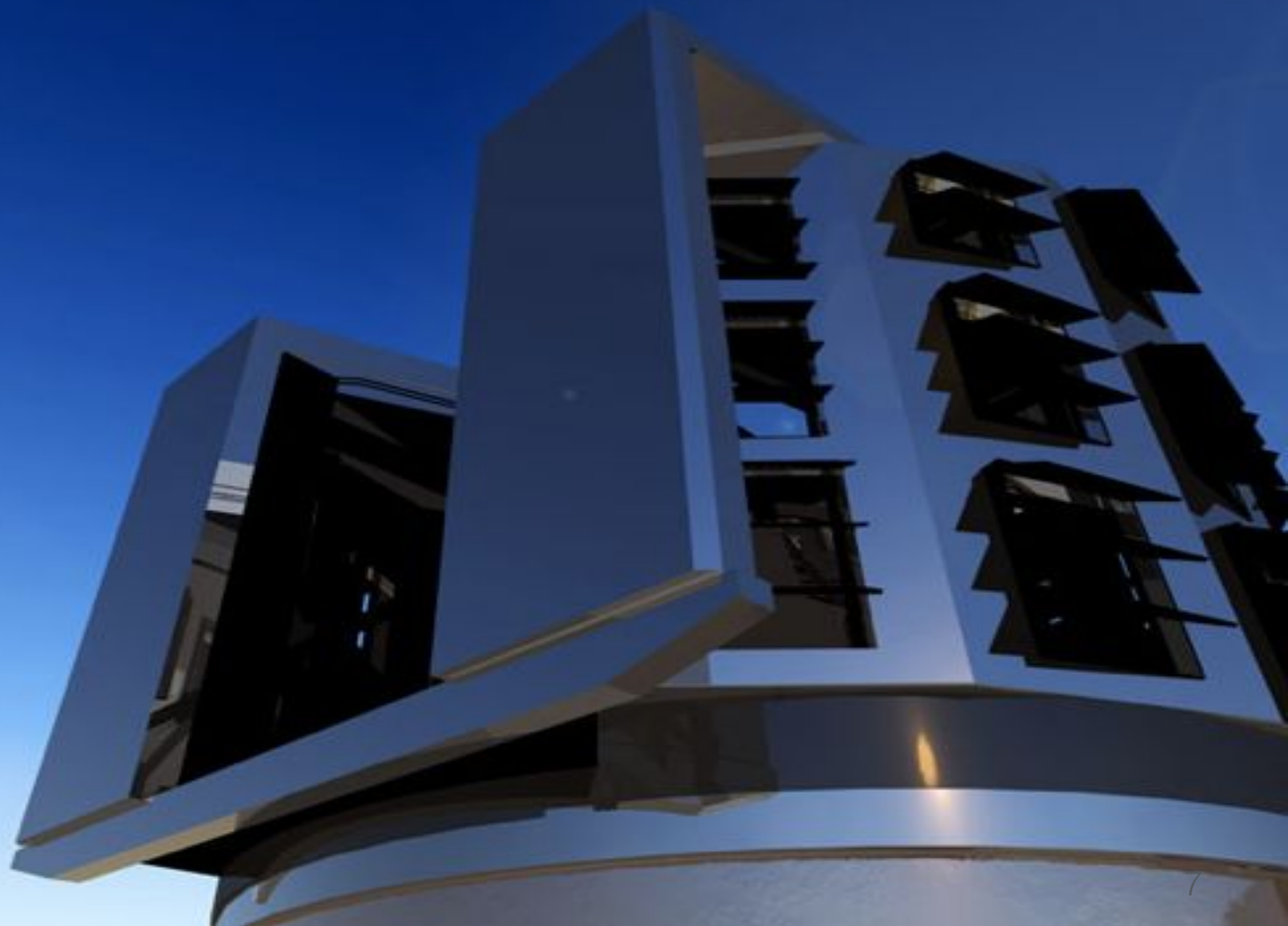
Large Synoptic Survey Telescope

Wide Fast Deep:

- More sky coverage
- More SN detected
- Low z

Deep Drilling Field:

- Less sky coverage
- Less SN detected
- High z



LSST Proposed Cadences

Cadence	σμ	Area
nexus_2097	0.1328	26446.5
pontus_2002	0.1319	26446.5
pontus_2502	0.1309	18008.5
mothra_2049	0.1312	26446.5
kraken_2036	0.1309	18008.5
mothra_2045	0.1311	16382.2

Avg mu = 0.1315

Cadence	σμ	Area
kraken_2035	0.1278	17969.9
kraken_2026	0.1268	18008.5
kraken_2044	0.1265	26446.5
kraken_2042	0.1263	18008.5
colossus_2664	0.1278	19357.6
colossus_2665	0.1278	18728.2

Avg mu = 0.1272

Avg mu = 0.1228

Cadence	σμ	Area
pontus_2489	0.1233	18008.5
colossus_2667	0.1222	18008.5

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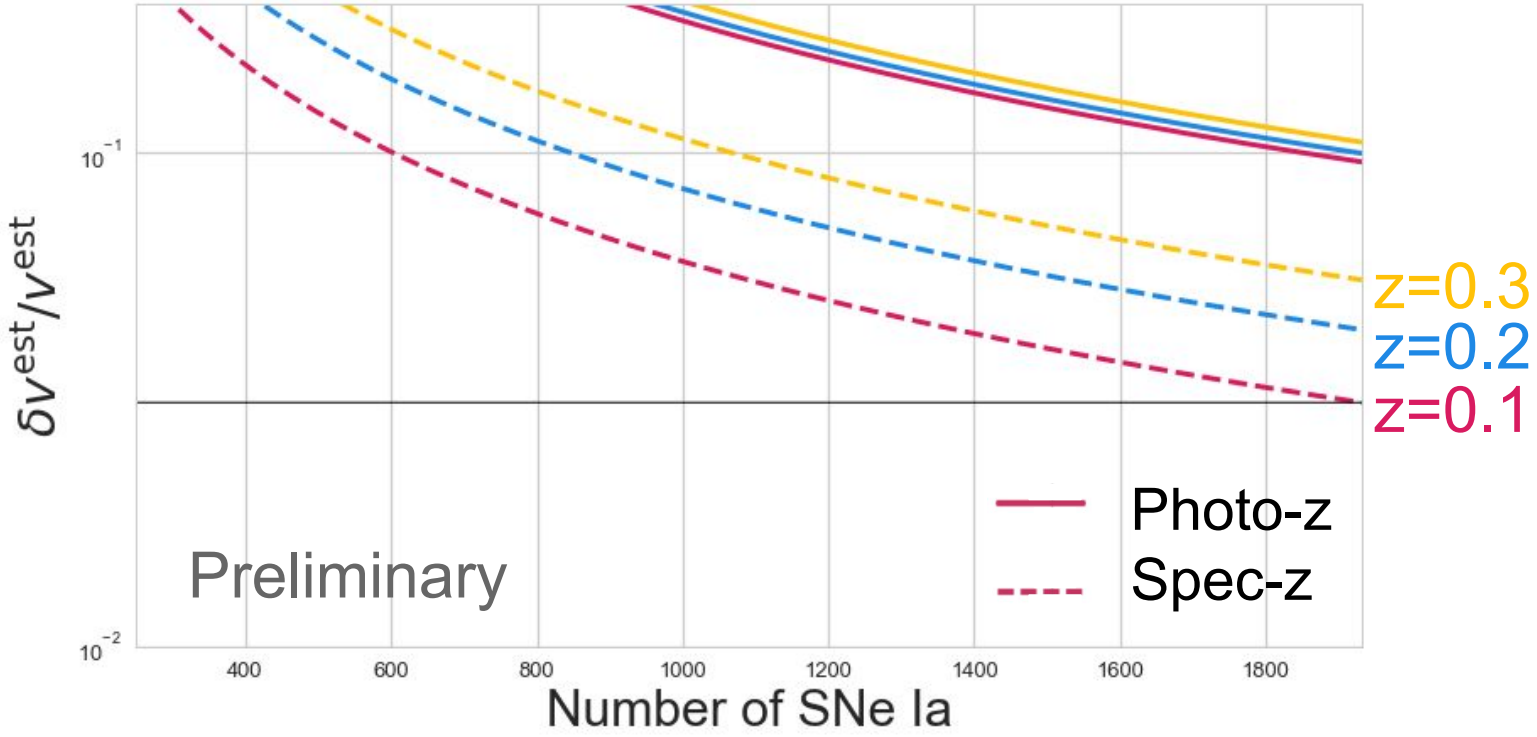
Error on Estimated Pairwise Velocity for LSST

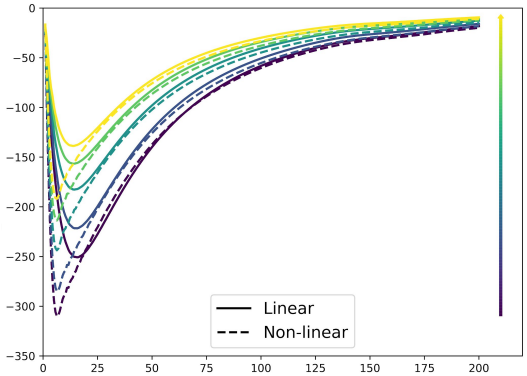


Fisher Matrix Analysis

$$\theta_i, j = \{\Omega_m, \Omega_\Lambda, w_0, w_a\}$$

$$F_{ij} = \sum_d \frac{\partial v(r, z, \theta_i)}{\partial \theta_i} C_d^{-1} \frac{\partial v\,(r, z, \theta_j)}{\partial \theta_j}$$

Fisher Matrix Analysis



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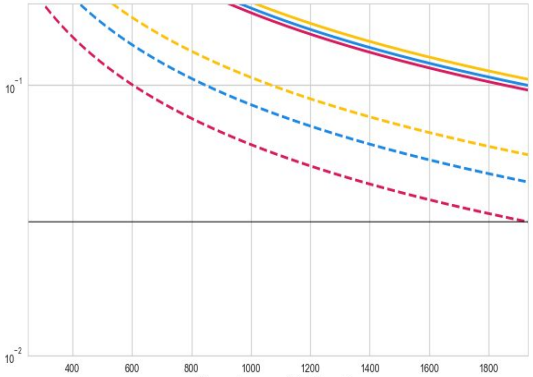
Fisher Matrix Analysis



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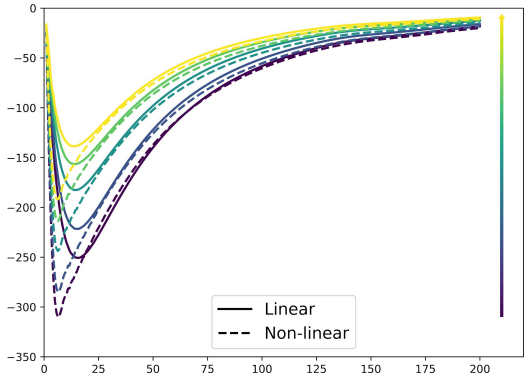

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Fisher Matrix Analysis

Error on the parameters

Parameter	Spectroscopic	Photometric
Ω_m	0.011	0.030
Ω_Λ	0.002	0.007
w_0	0.040	0.101
w_a	0.125	0.313

Preliminary

Fisher Matrix Analysis

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Preliminary

Future Work

- Incorporate distribution of SNe Ia into my calculation

- Get a realistic SN catalog by placing SN inside host galaxies based on host galaxy properties and calculate peculiar velocities based on this catalog

Conclusion

- Galaxy peculiar velocities can be an effective cosmological probe to study growth of structure

- LSST will observe many SNe Ia that can be used for this study

- We can get constraint on cosmological parameters comparable to Planck with just a few thousand SNe Ia

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