Cosmology with Peculiar Velocities: Observational Effects

Per Andersen

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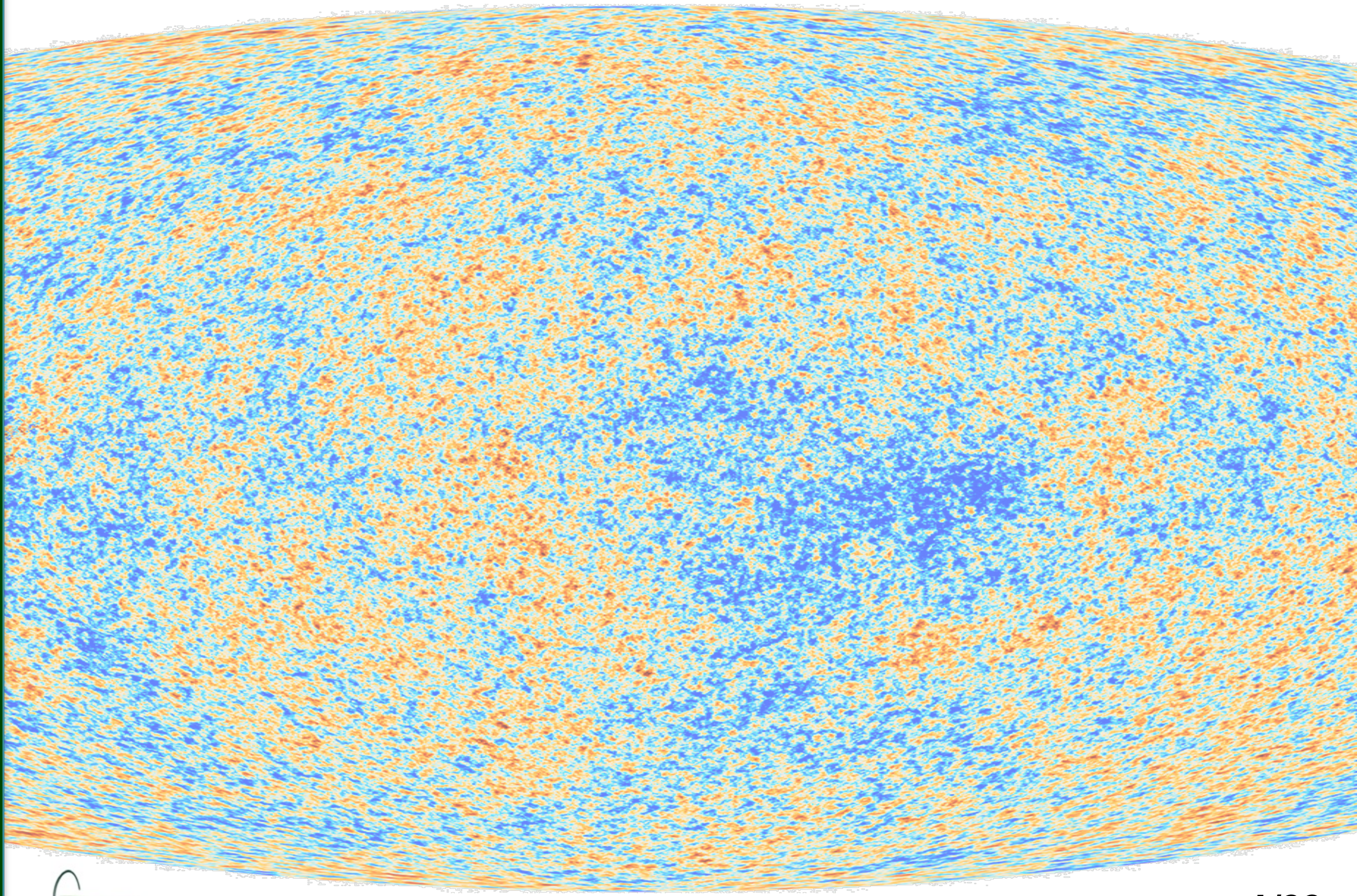
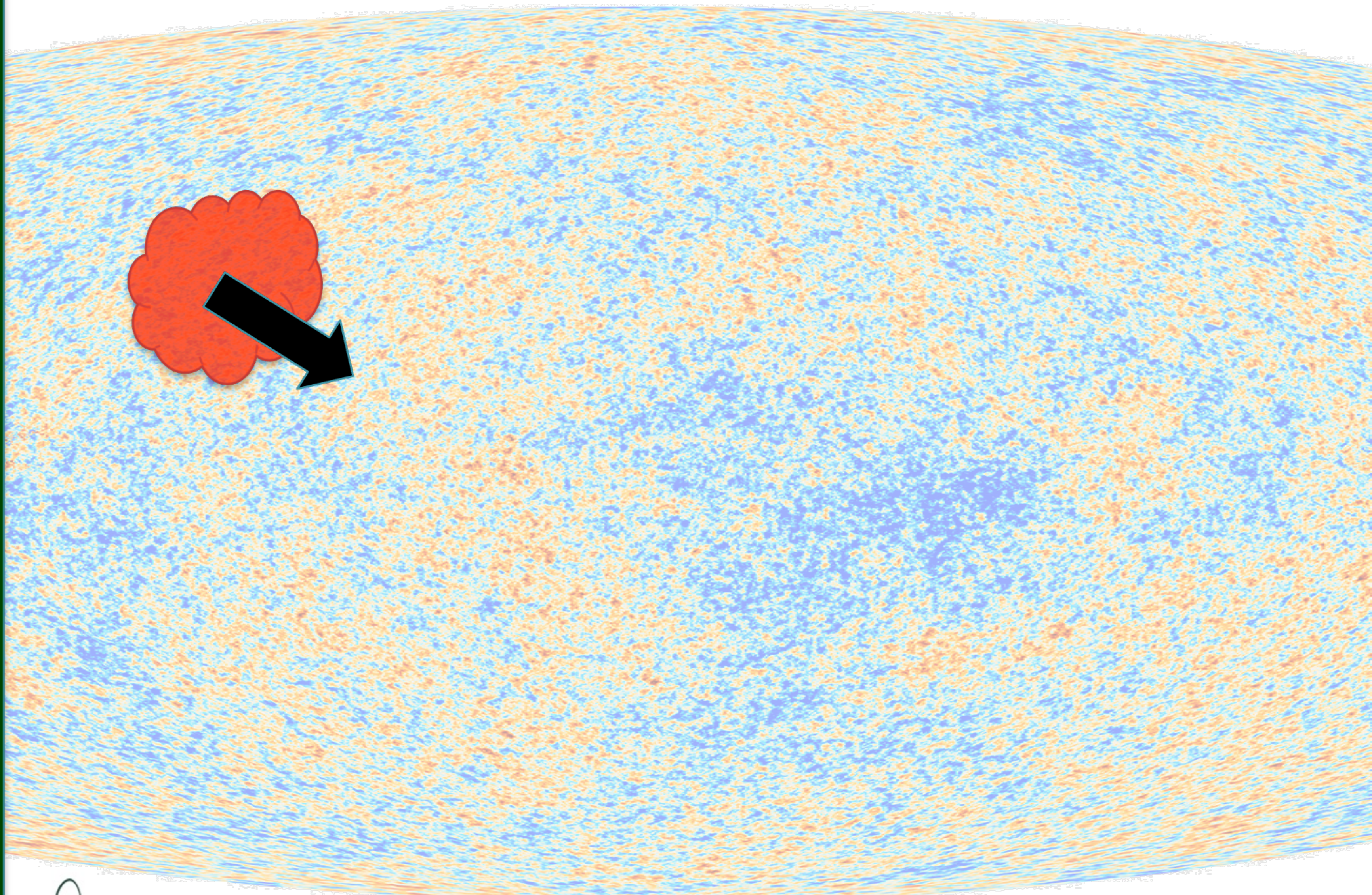
Bulk Flows



Bulk Flows



Bulk Flows

- **Discrepancy in agreement with ΛCDM of measured bulk flows**
- **Observational bias?**

  \- Survey geometry (not full sky coverage)

  \- Undersampling (few data points)
- **Focus on type Ia SNe surveys**

Plan of Attack – Use Simulation (Horizon Run 2)

Actual

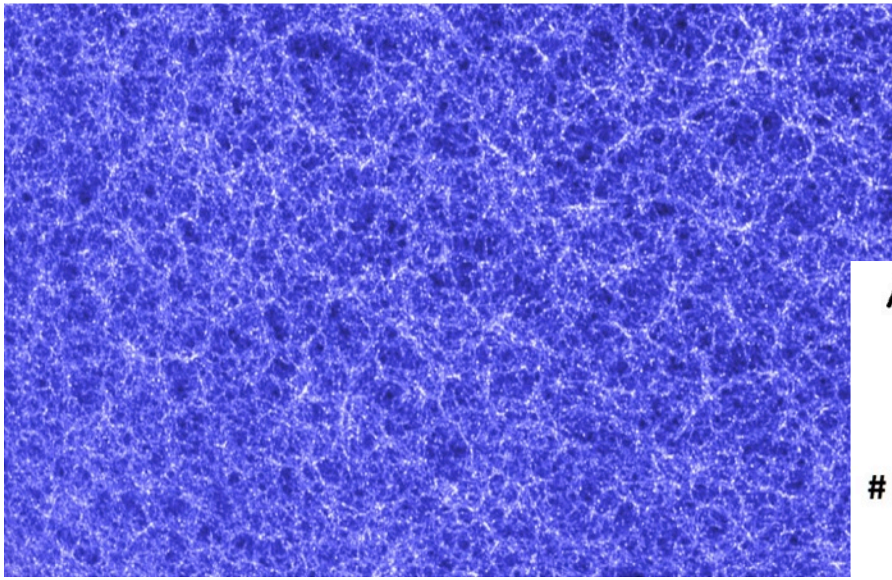
- All galaxies
- Full 3d info
- Averaged flow
- Compare with linear theory

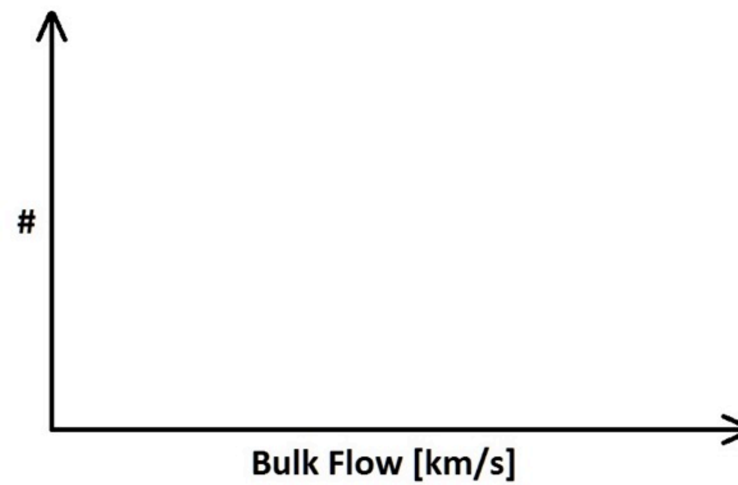
Measured

- Galaxy subsample
- Line-of-sight info
- Estimated flow:

Maximum Likelihood
Minimum Variance

Measuring Bulk Flows from Simulation





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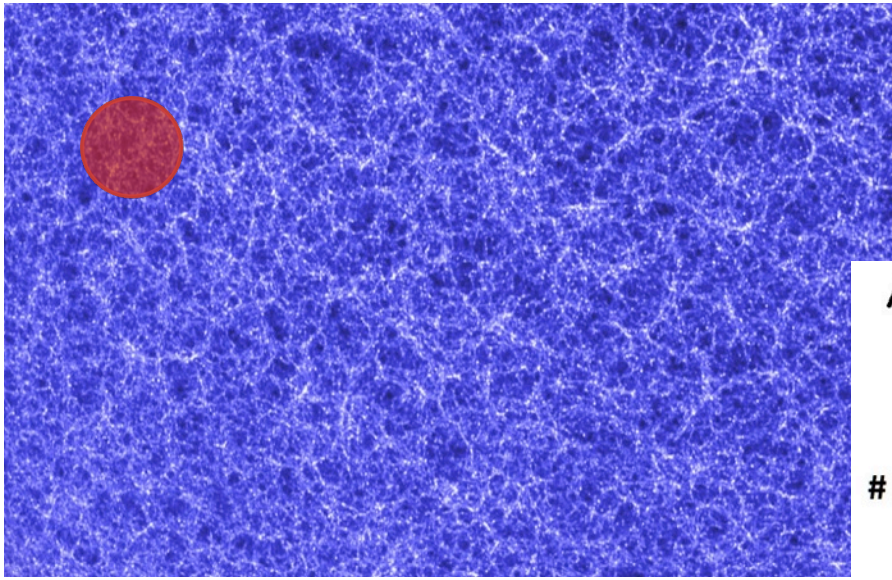

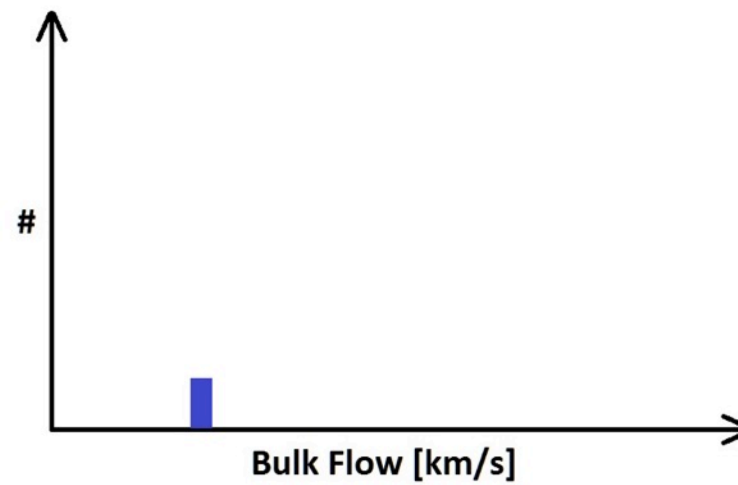

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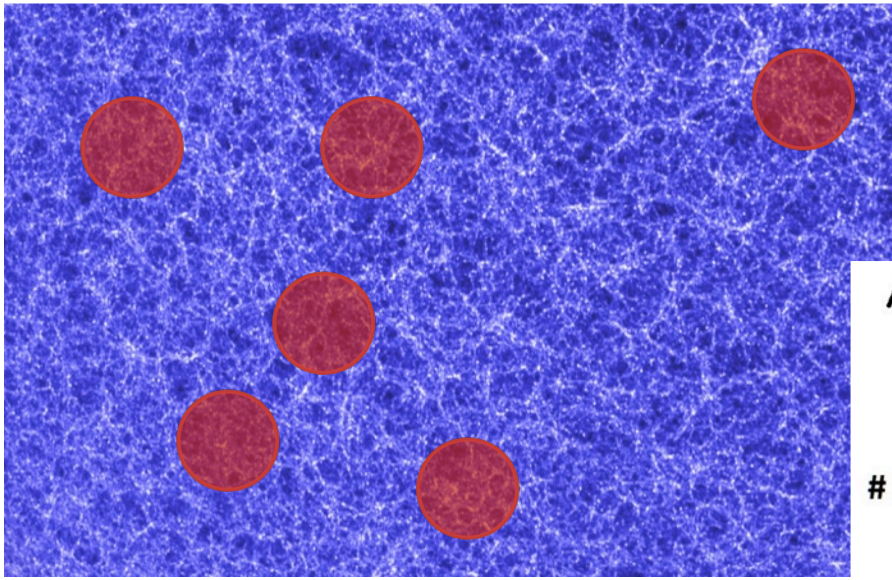

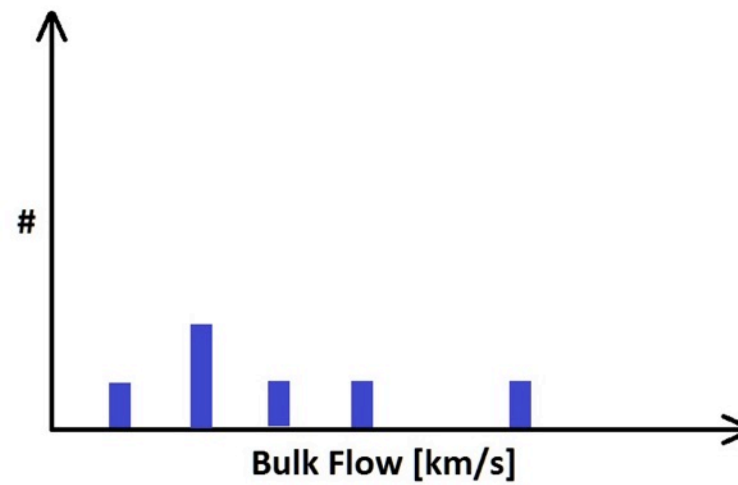

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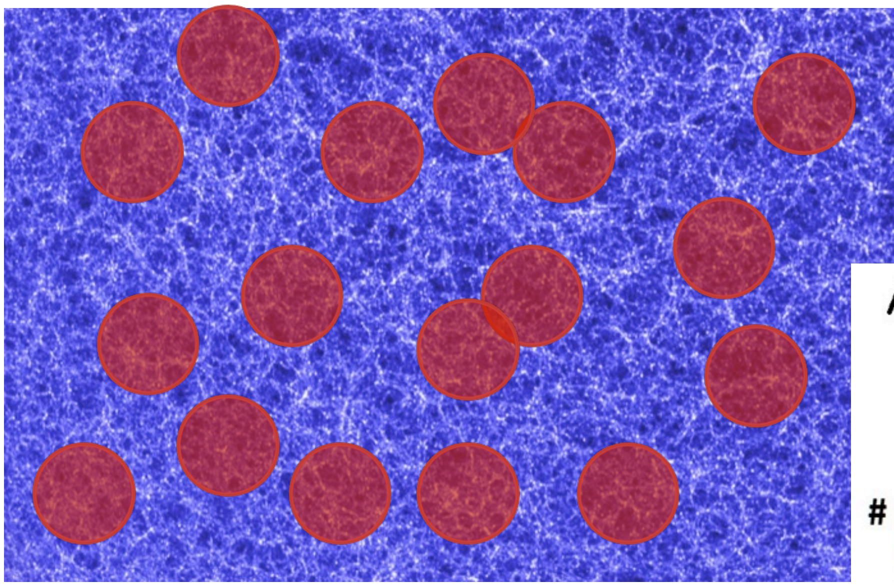
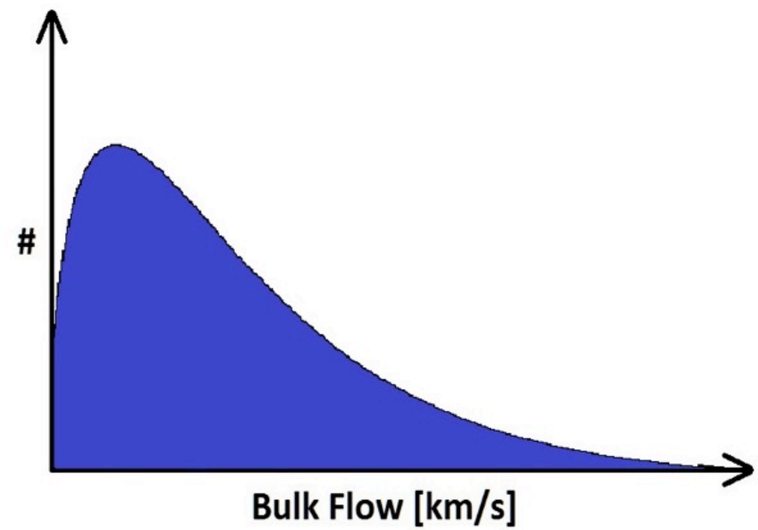
Measuring Bulk Flows from Simulation





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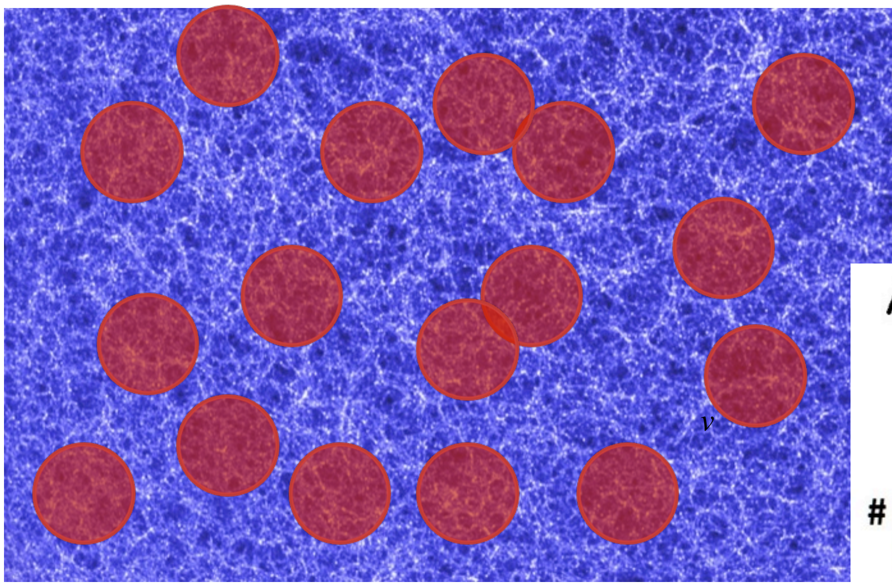
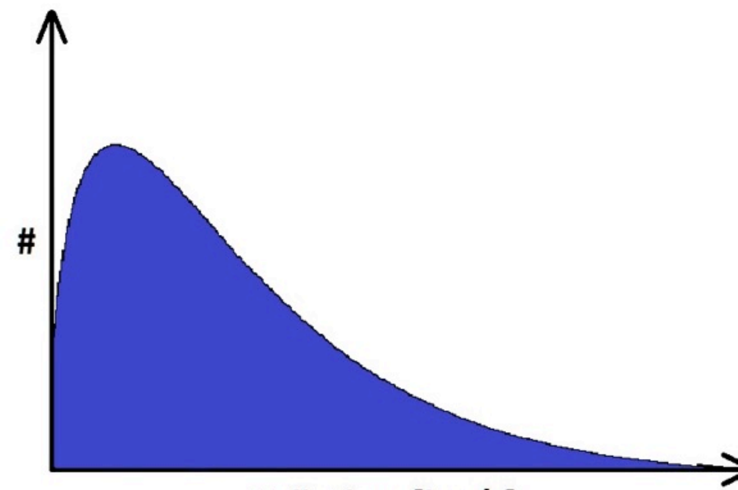
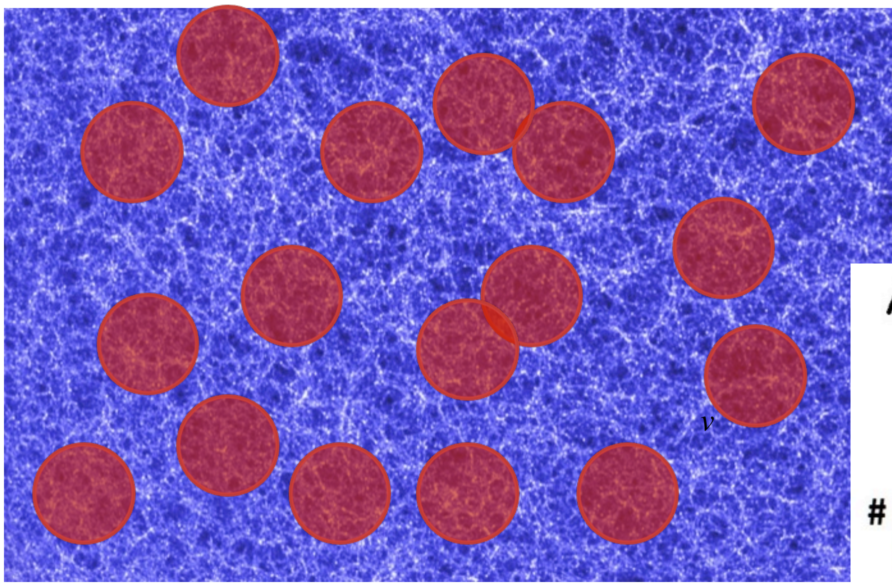
Measuring Bulk Flows from Simulation



$$v^2 = v_x^2 + v_y^2 + v_z^2$$



Measuring Bulk Flows from Simulation



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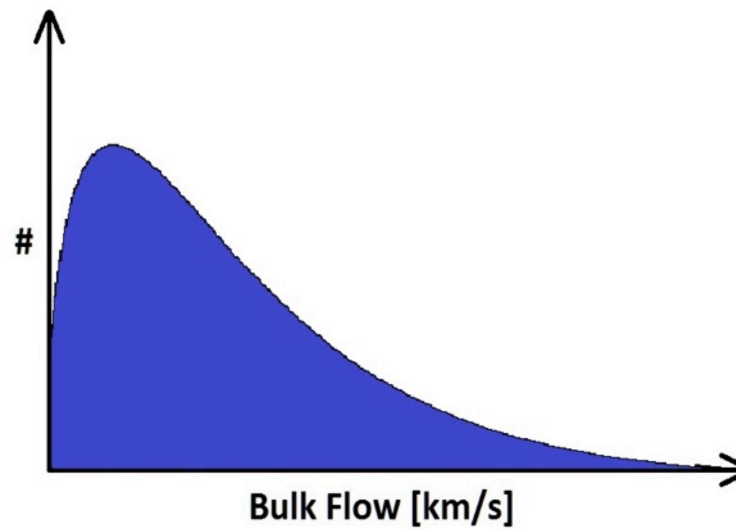

$$p(V)\mathrm{d}V = \sqrt{\frac{2}{\pi}}\left(\frac{3}{\sigma_V^2}\right)^{3/2} V^2 \exp\left(-\frac{3V^2}{2\sigma_V^2}\right)\mathrm{d}V.$$

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Bulk Flow – Linear Theory

$$\sigma_V^2(\boldsymbol{r}) = \int \frac{\mathrm{d}^3k}{(2\pi)^3} P_{vv}(k) \left|\widetilde{W}(\boldsymbol{k};\boldsymbol{r})\right|^2$$

Bulk Flow – Linear Theory

From cosmology

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Bulk Flow – Linear Theory

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From survey geometry

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Bulk Flow – Linear Theory

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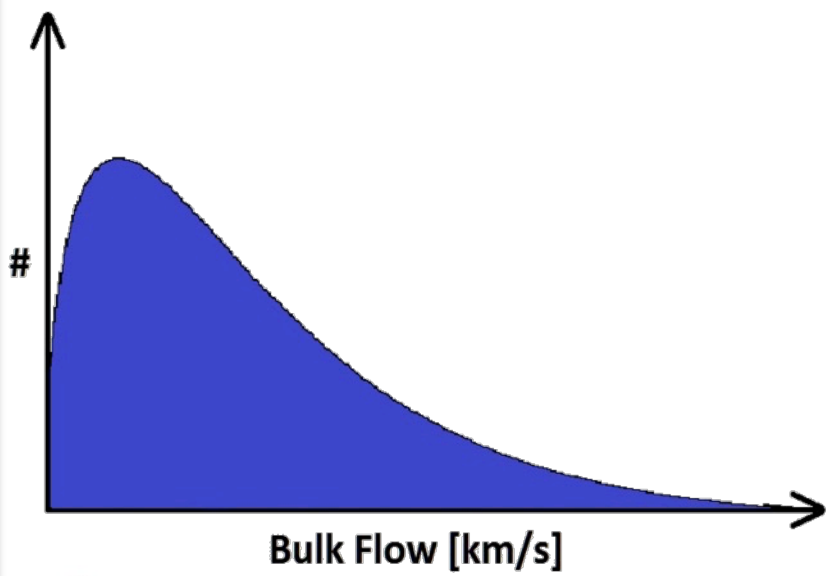


Bulk Flow – Linear Theory

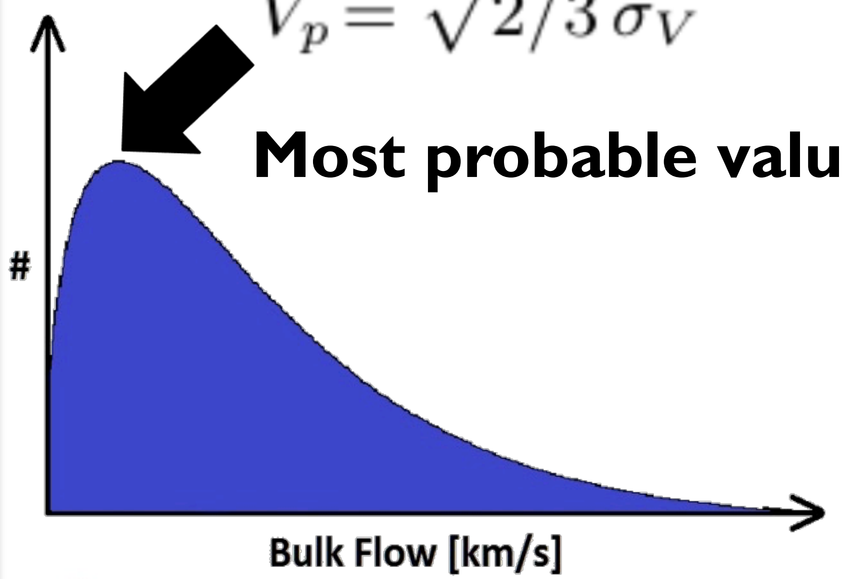
From cosmology

$$\sigma_V^2(\boldsymbol{r}) = \int \frac{\mathrm{d}^3 k}{(2\pi)^3} P_{vv}(k) \left|\widetilde{W}(\boldsymbol{k};\boldsymbol{r})\right|^2$$

From survey geometry

$$V_p = \sqrt{2/3}\,\sigma_V$$

Most probable value



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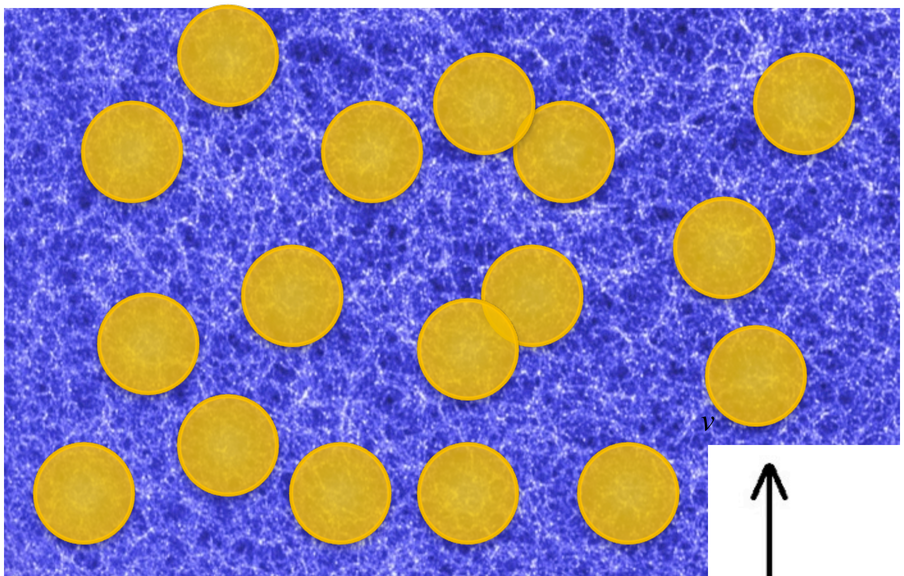
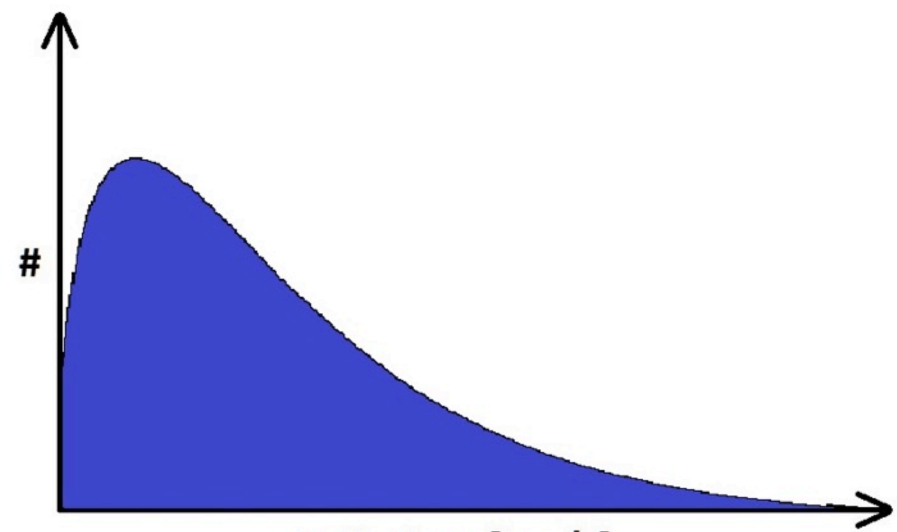
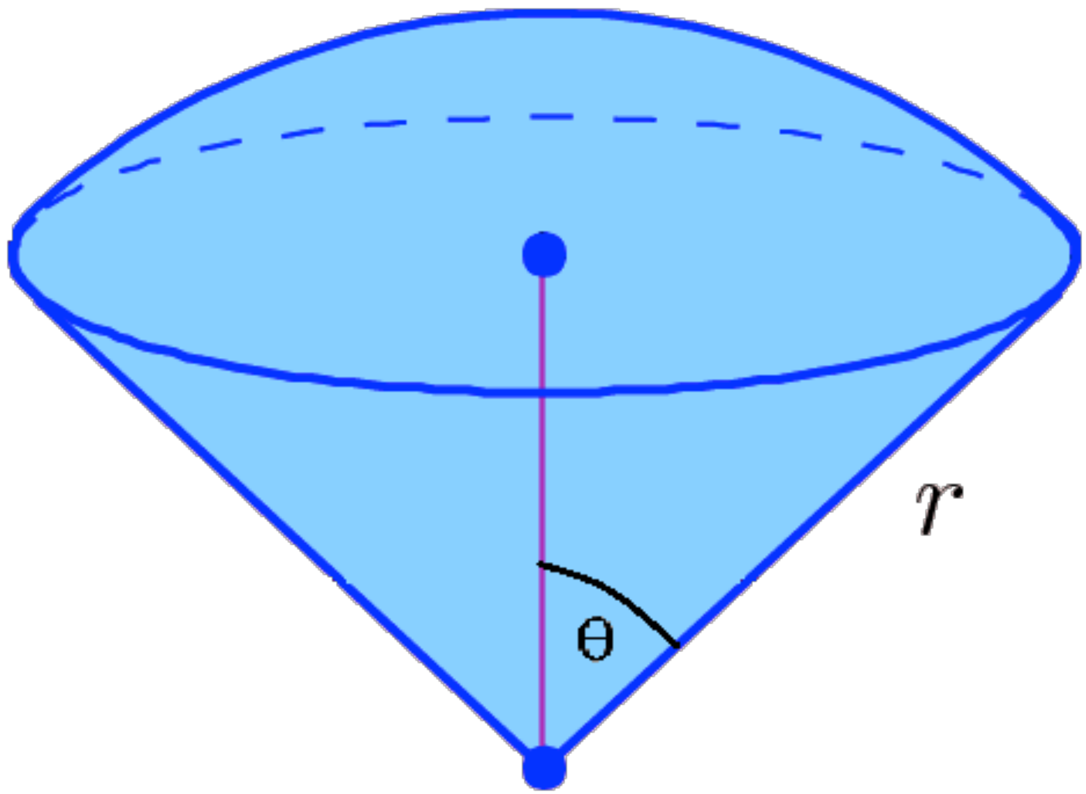
Bulk Flow – Estimator Performance



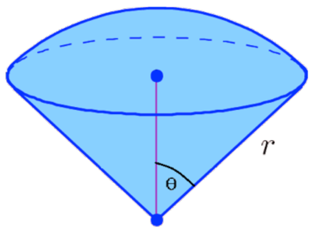
N ~ 50000
n = 500



Idealised Survey– Spherical Cone Geometry



Bulk Flow - Results



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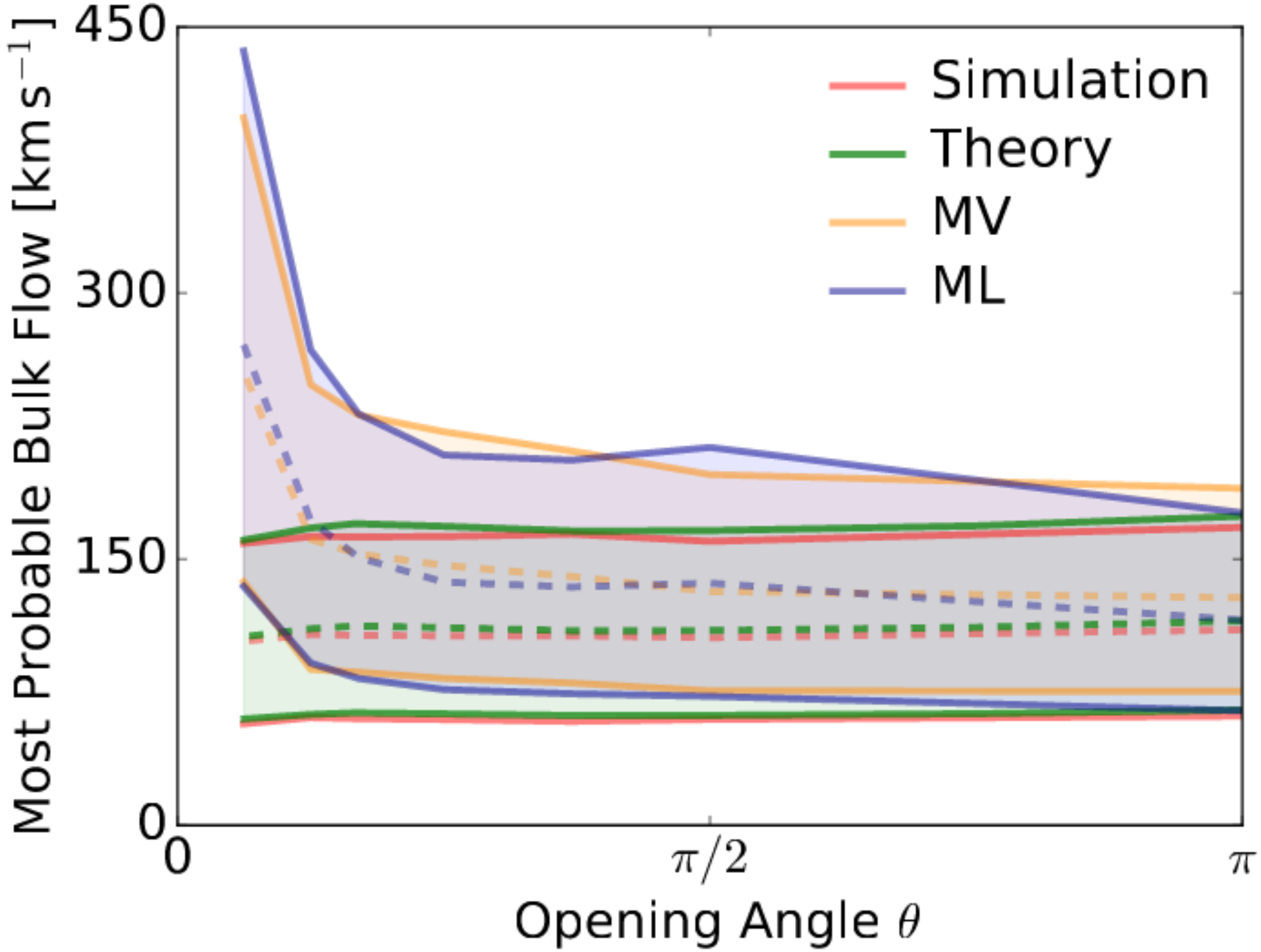

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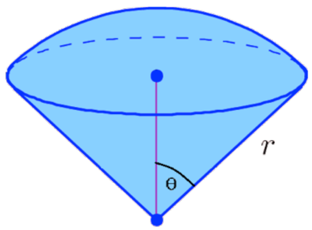

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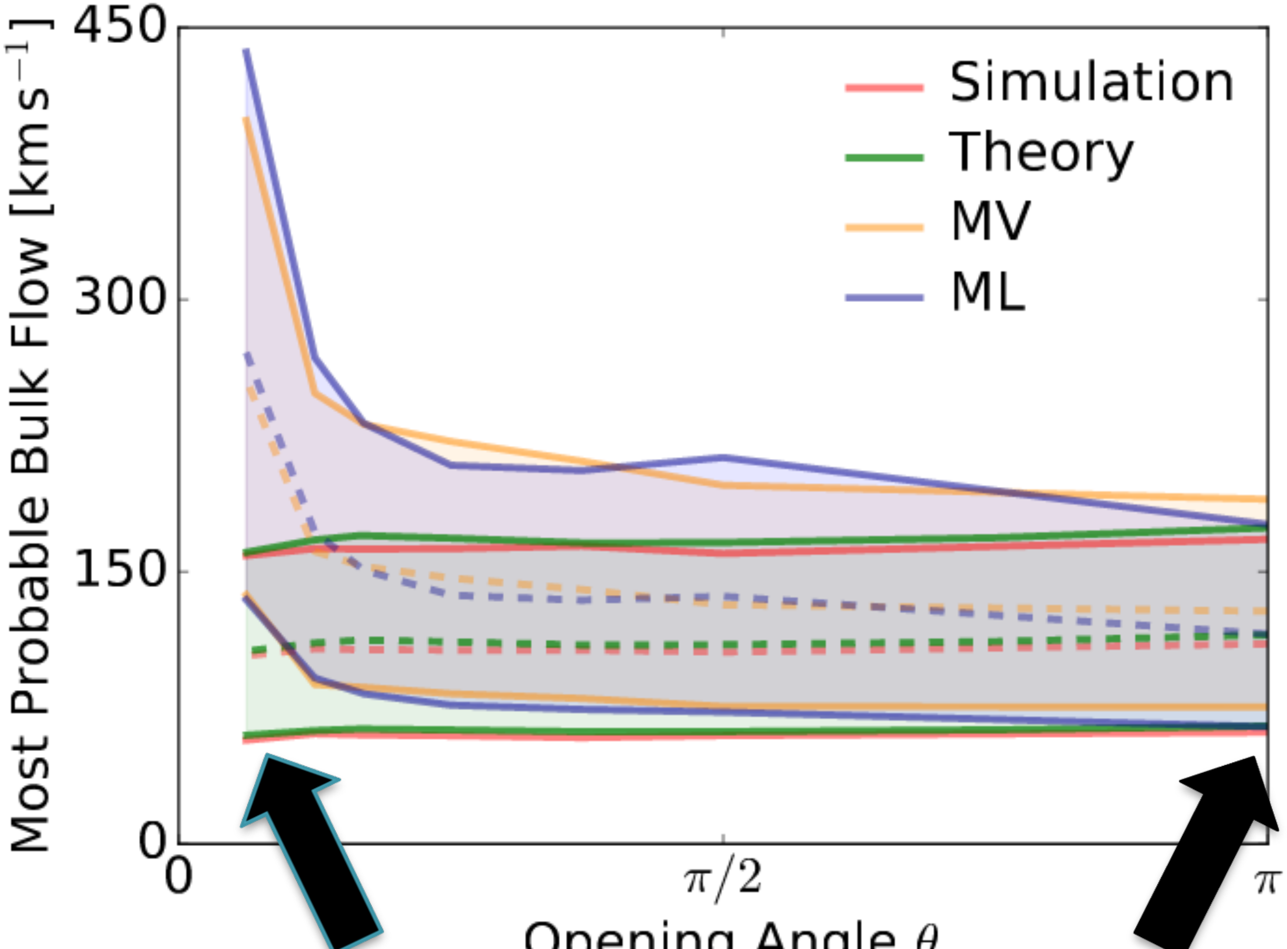

***r* ~ 1 Gpc** ***r* ~ 200 Mpc**

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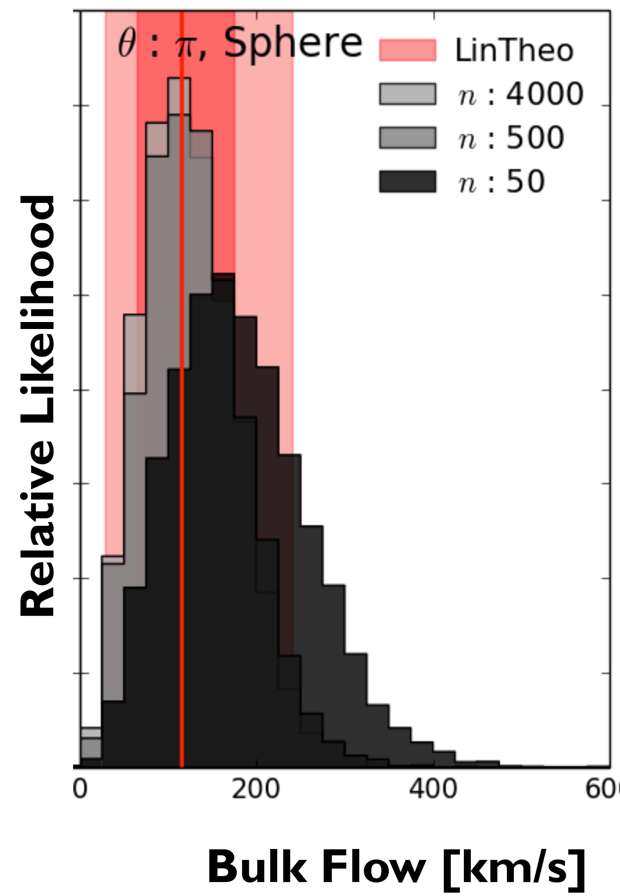
Bulk Flow - Results



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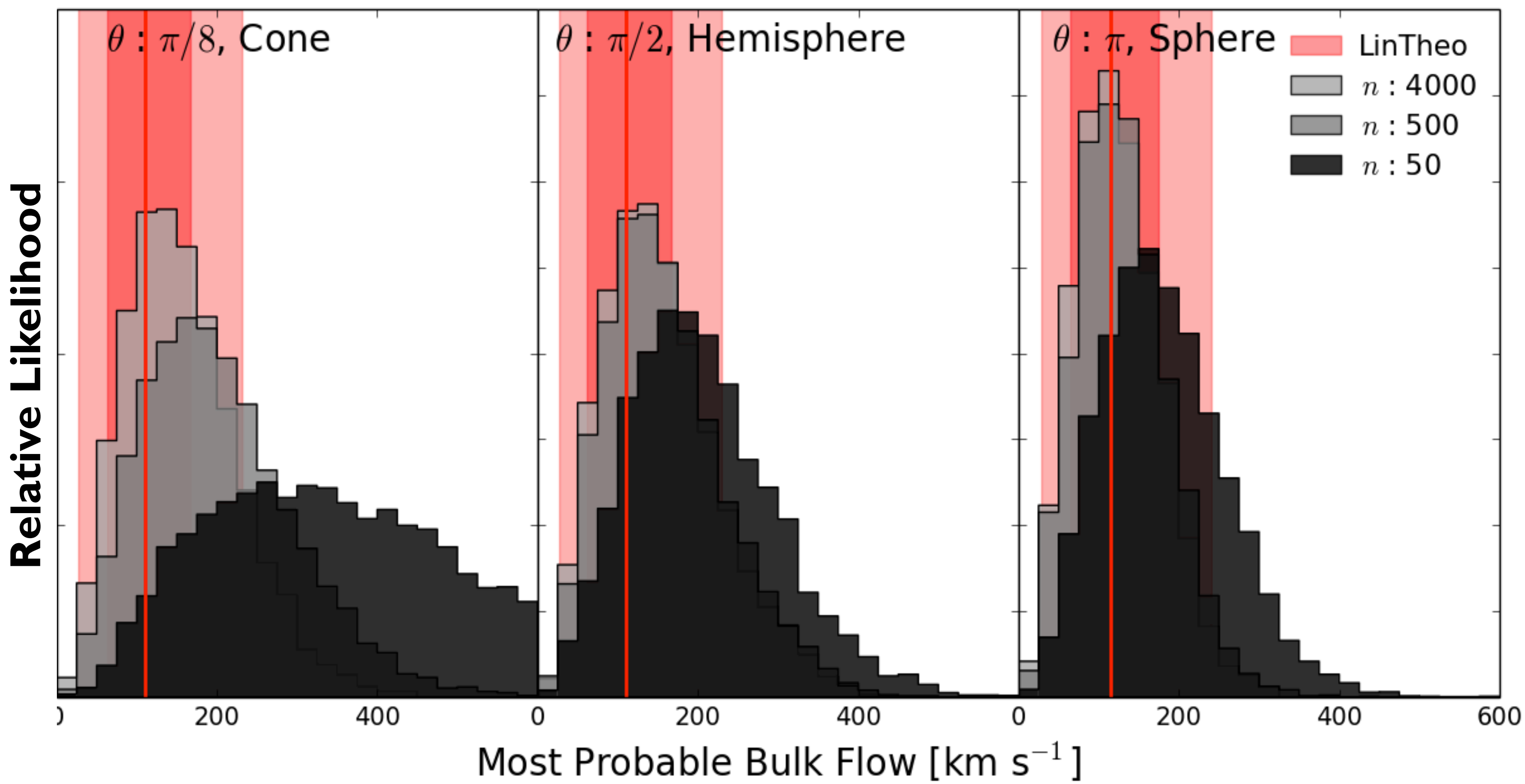

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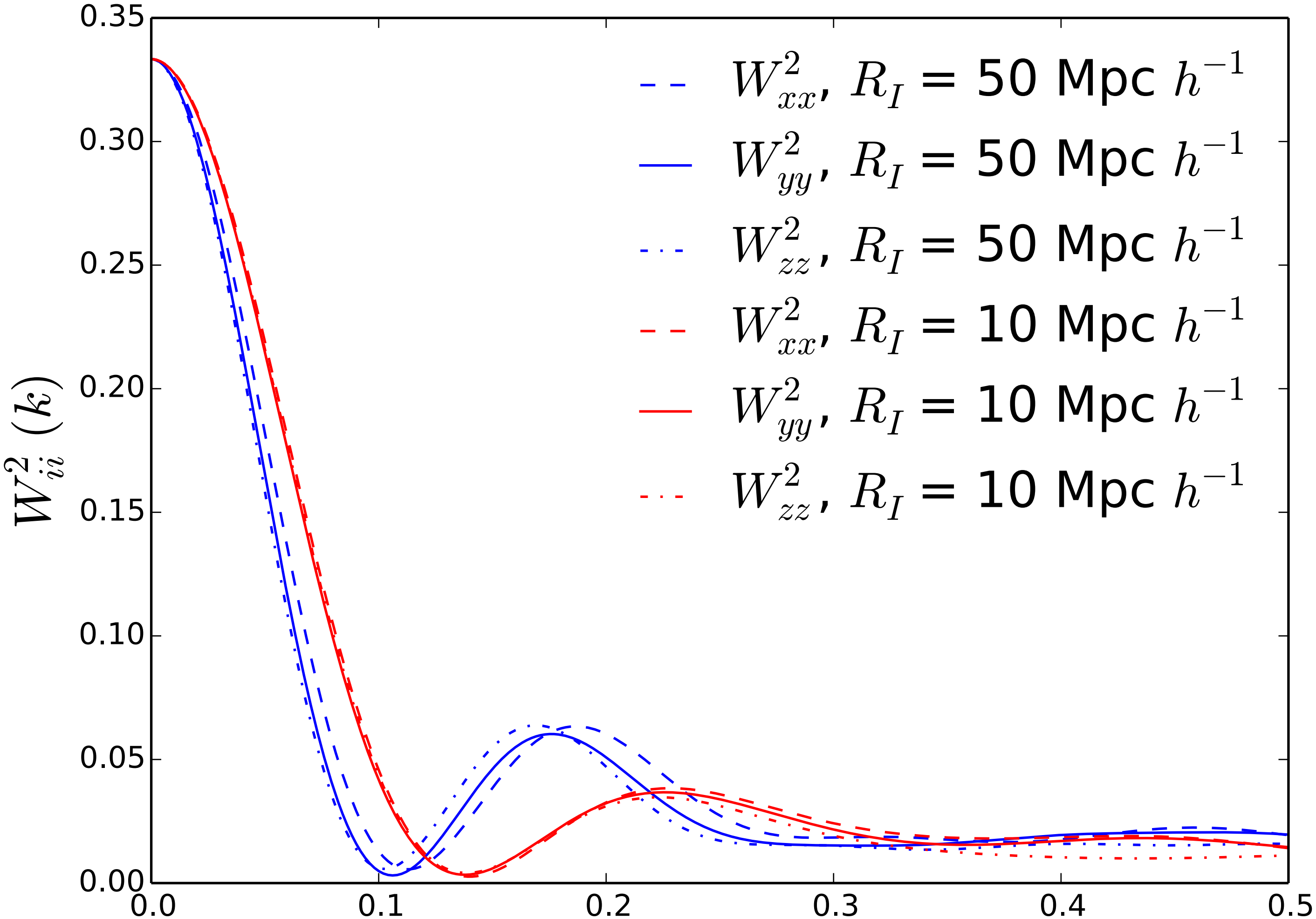
Bulk Flow - Conclusion

- **Found:** Significant bias in bulk flow measurement compared to theoretical prediction from both undersampling and non-spherical geometries

- **Solution:** Use simulation rather than linear theory prediction to compare measured bulk flows with theory

Bulk Flow – Extra Slides



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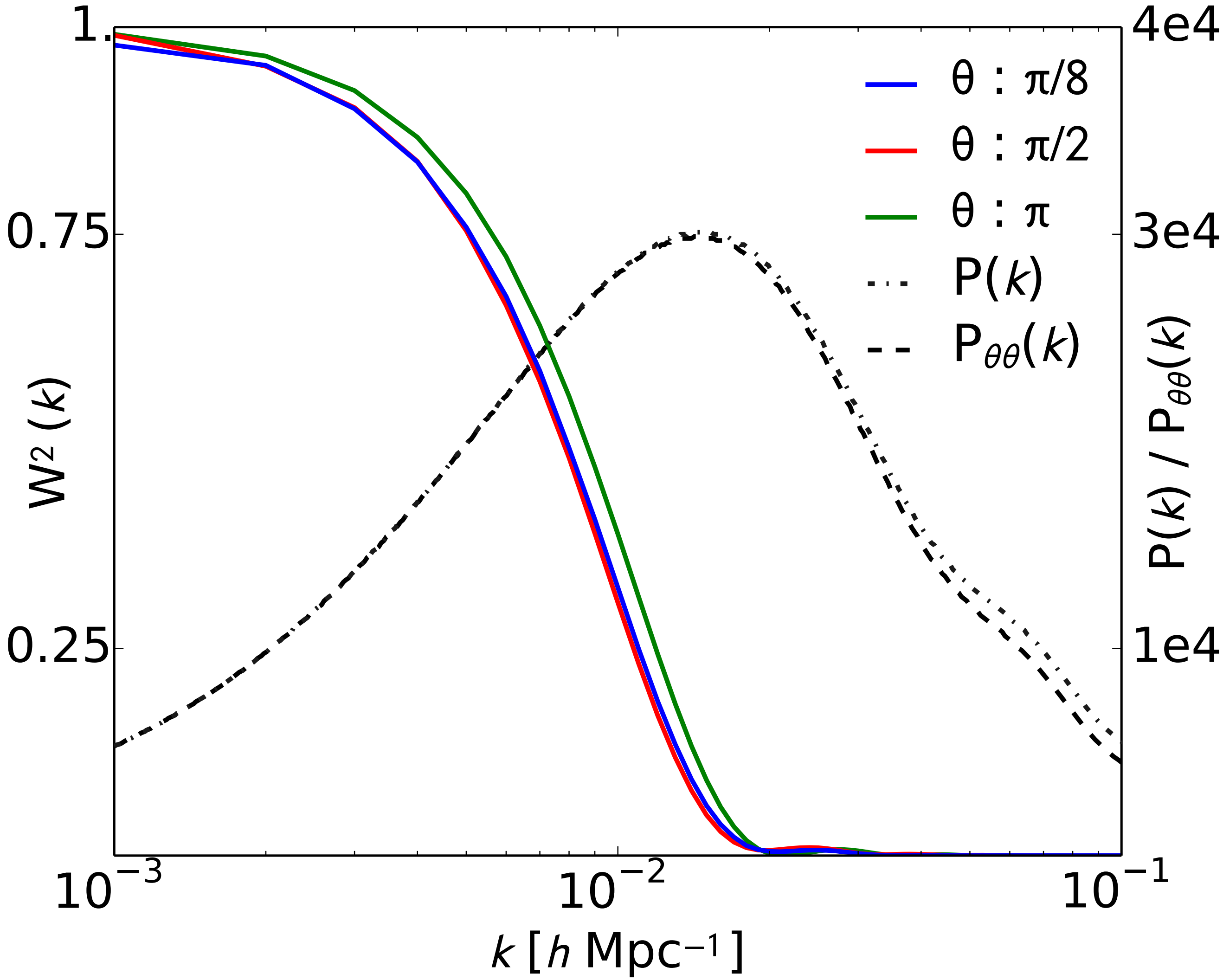
Bulk Flow – Extra Slides



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Bulk Flow – Extra Slides