

# Gravitational Screening

## *Nonlinearity of Superposition*

Robert Caldwell / Dartmouth College / 8 April 2013  
IPMU, Tokyo, Japan



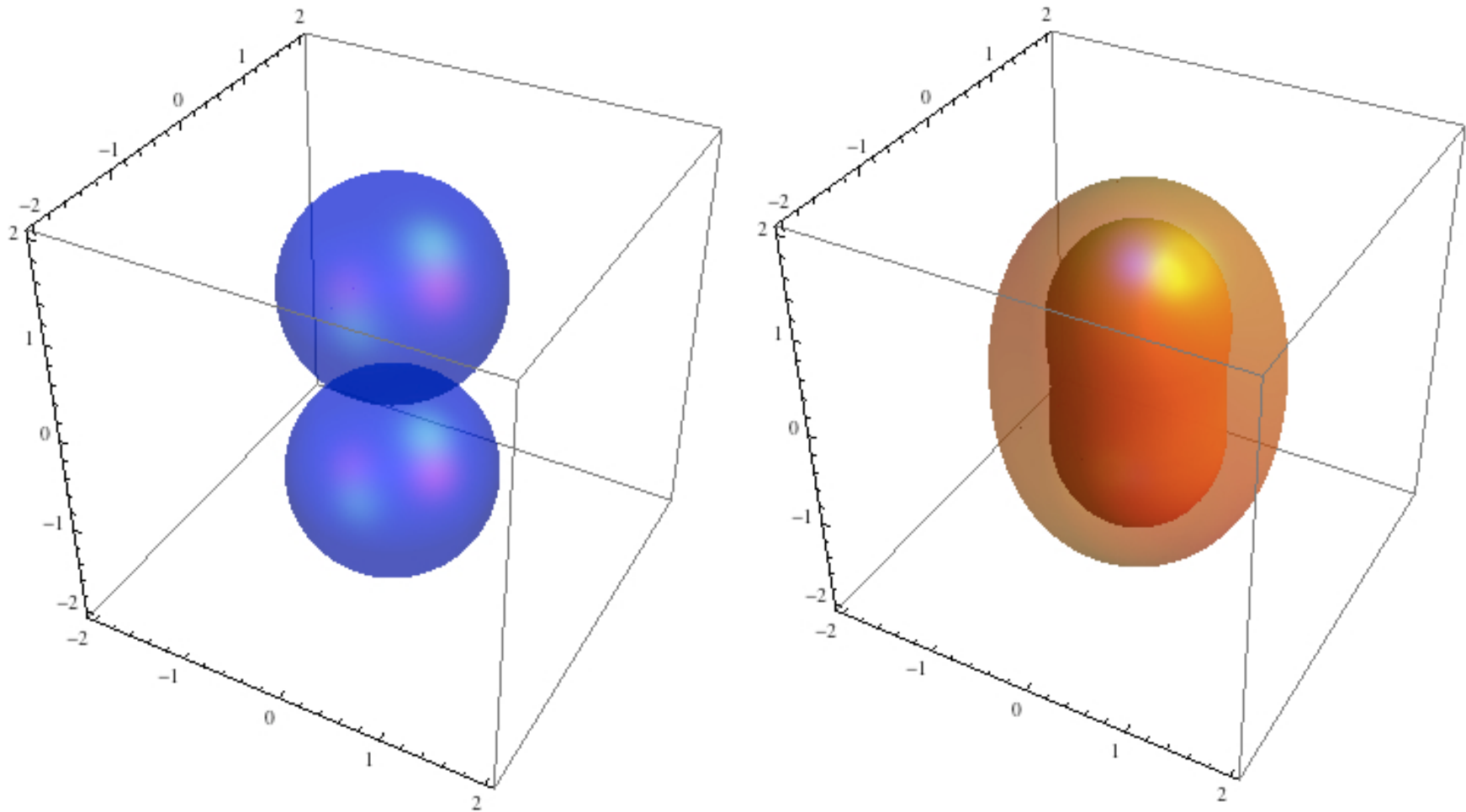
## ***Fascinating Equation...***

$$\begin{aligned}\nabla^2 \pi + \lambda^2 \left( (\nabla^2 \pi)^2 - (\nabla_i \nabla_j \pi)^2 \right) + \dots \\ = -\frac{\kappa}{3} T + \frac{2\kappa}{3} \lambda^2 \partial_\mu \partial_\nu \pi T^{\mu\nu}\end{aligned}$$

- Spheres, other geometry?
- Superposition?
- Methods of solution
- Newtonian, post-Newtonian physics

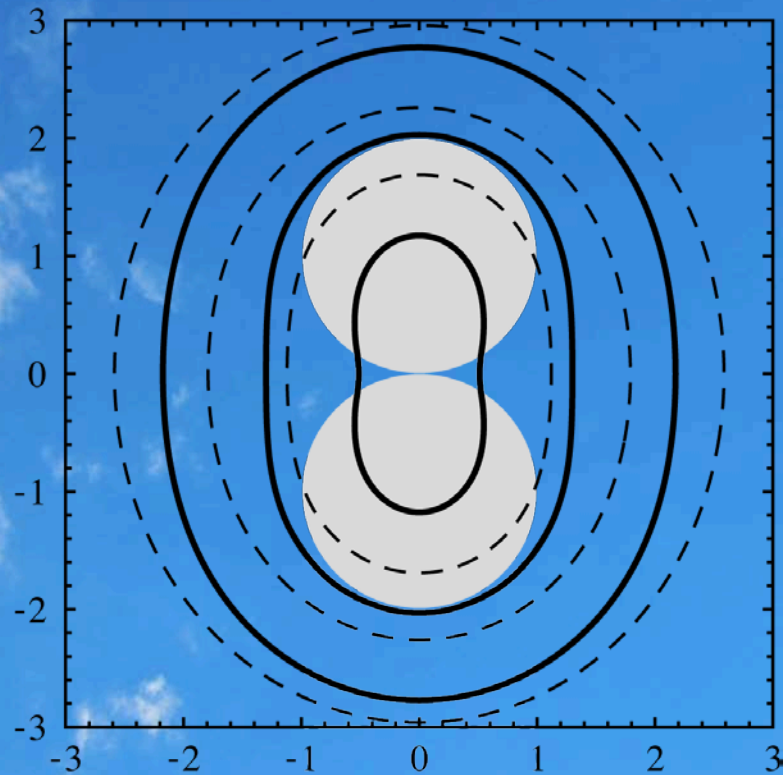
# ***Library***

- *Self-consistent cosmological simulations of DGP braneworld gravity,*  
Schmidt, PRD 80, 043001 (2009)
- *N-Body simulations of DGP and degravitation theories,*  
Khoury and Wyman, PRD 80, 064023 (2009)
- *Exploring Vainshtein mechanism on adaptively refined meshes,*  
Li et al, 1303.0008
- *Simulations of Galilean modified gravity,*  
Wyman et al, 1303.6630
- *Nonlinearity and Superposition*  
Caldwell and Bielefeld, *in progress*



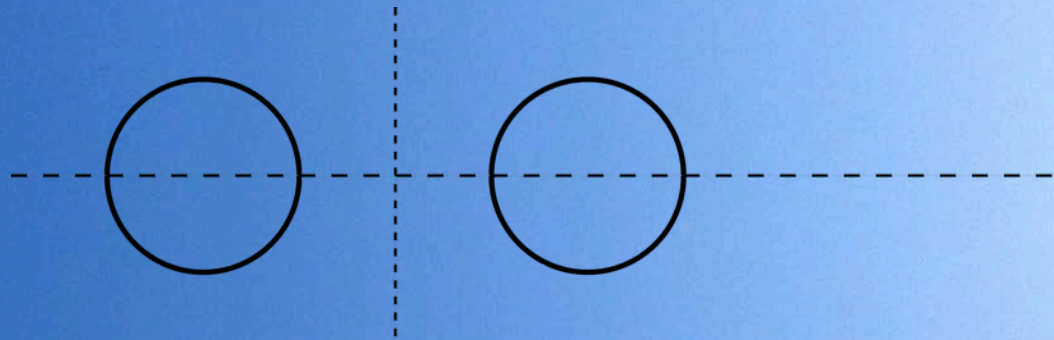
Two galaxy clusters: 2 Mpc radii, at separation 2 Mpc, with screening radius 5 Mpc

# Superposition?

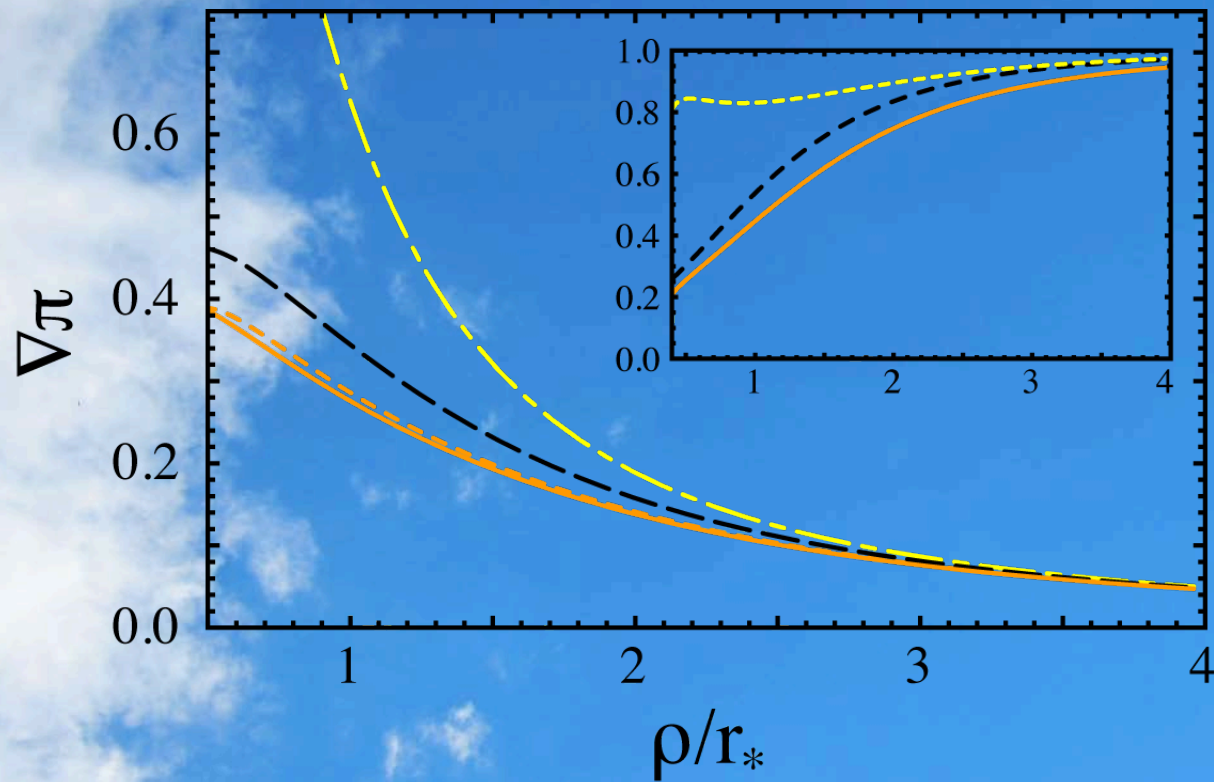


# *Analytic Solution Method*

$$\vec{\nabla} \pi = \epsilon \vec{\nabla} \Phi$$

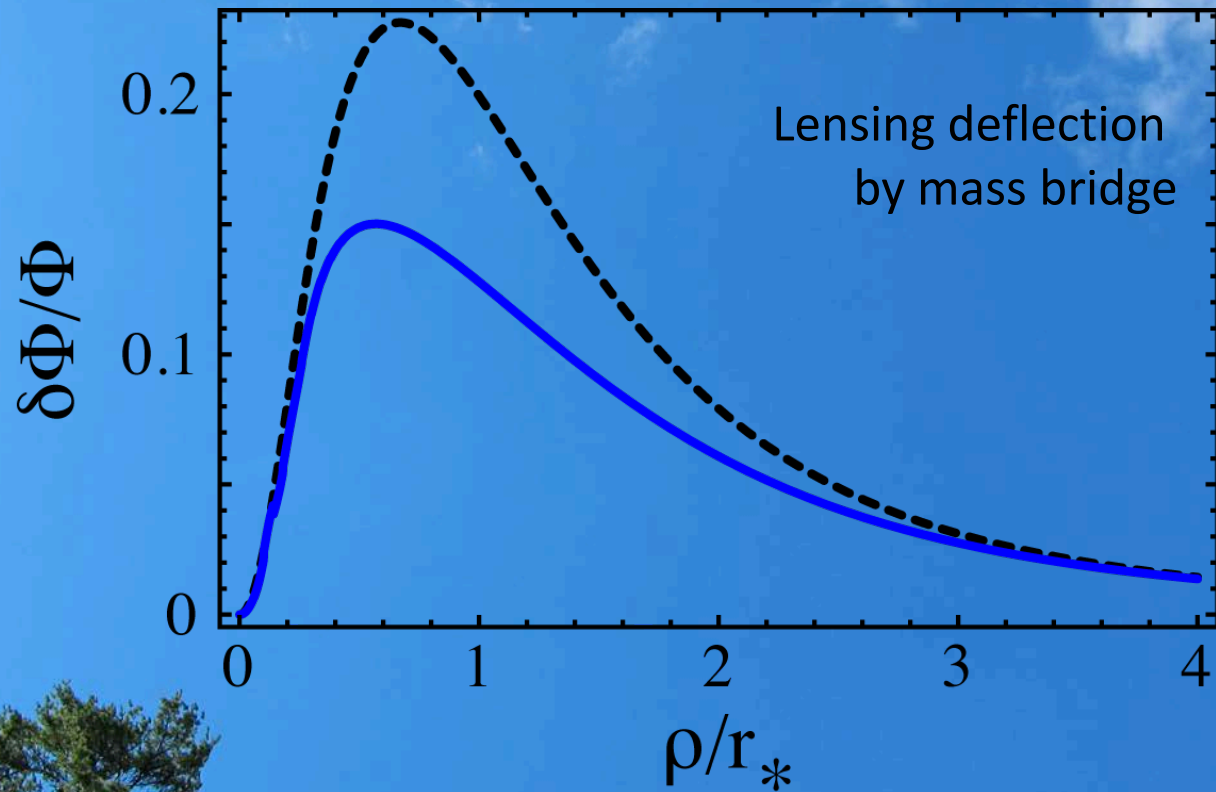


# Superposition?



## Superposition?

$$h_{\mu\nu} \rightarrow h_{\mu\nu} + \pi\eta_{\mu\nu} + \lambda^2\partial_\mu\pi\partial_\nu\pi$$





LETTER

Nature: July 4, 2012

## A filament of dark matter between two clusters of galaxies

Jörg P. Dietrich, Norbert Werner, Douglas Clowe, Alexis Finoguenov,  
Tom Kitching, Lance Miller & Aurora Simionescu

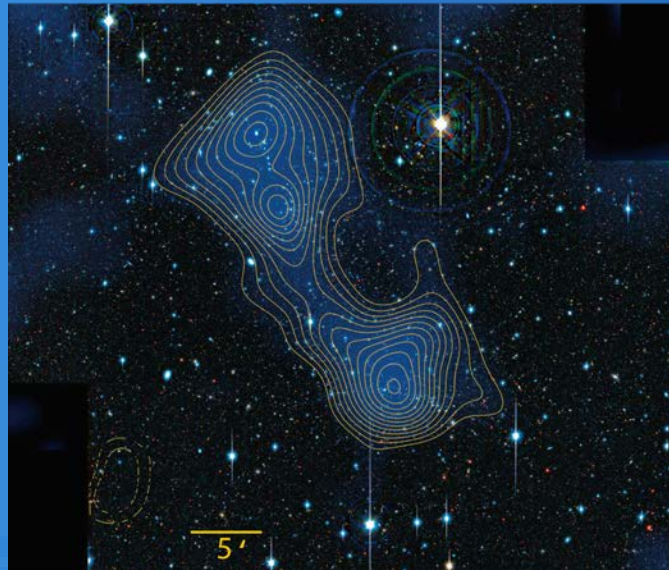


Figure 1 | Mass reconstruction of Abell 222/223.