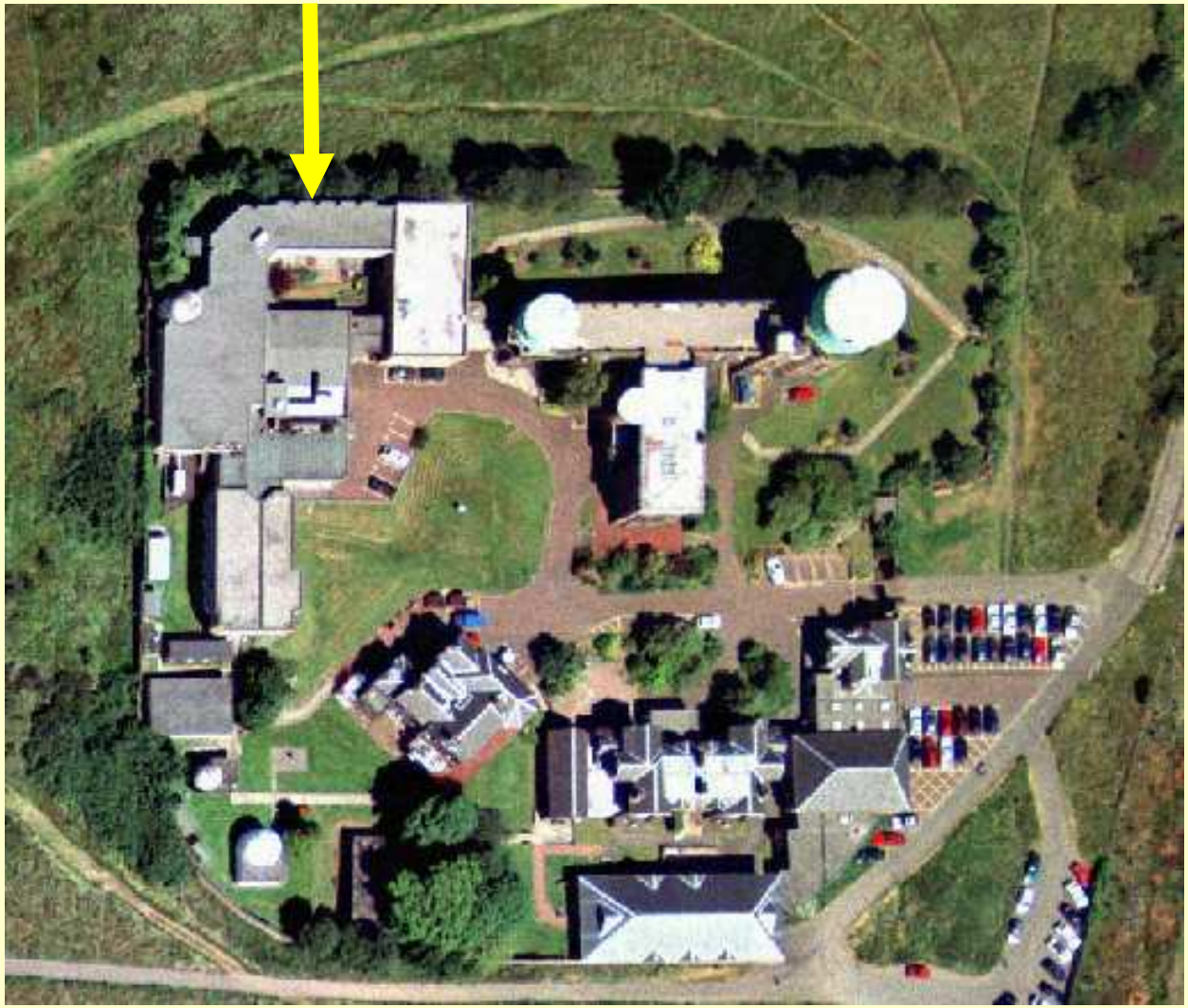
Alternative Gravities



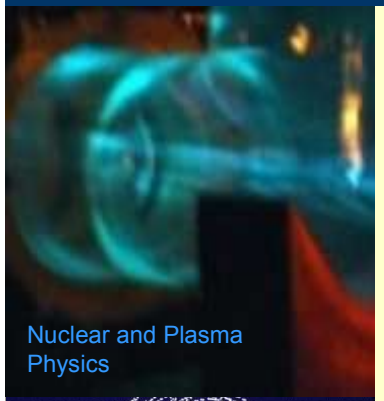
- Motivation
- Challenges

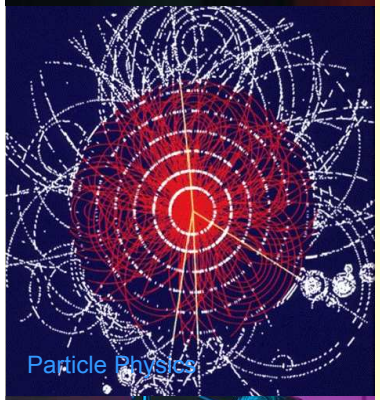
John Peacock

Edinburgh, 20 April 2006

Unifying Physics in Scotland

Scottish Universities Physics Alliance


Nuclear and Plasma Physics


Particle Physics

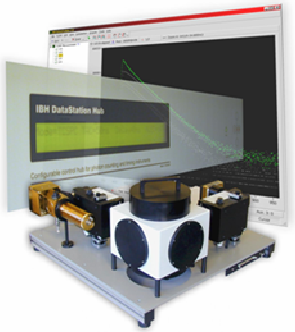

Photonics

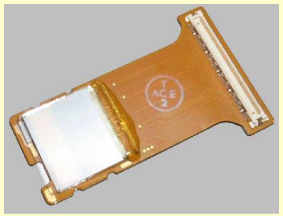
PHYSICS

- Physics is a core science: it underpins all areas of engineering, technology and the life sciences.
- Scotland's knowledge-based economy needs physics technology and skills.
- A physics alliance, building on our strengths, will compete with the best global players.

SUPA

- Creates a national strategy for physics in Scotland; builds the largest physics research alliance in the UK.
- Brings together Scotland's strongest physics research activities, enhancing our international leadership role.
- Creates a global identity for physics in Scotland, attracting incoming researchers and sponsors worldwide.





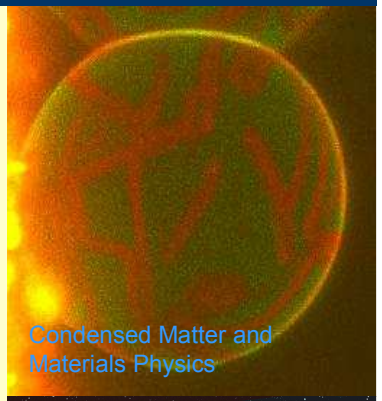
Courtesy: Horiba Jobin Yvon IBH Ltd; Coherent Scotland Ltd; CRLO Displays Ltd

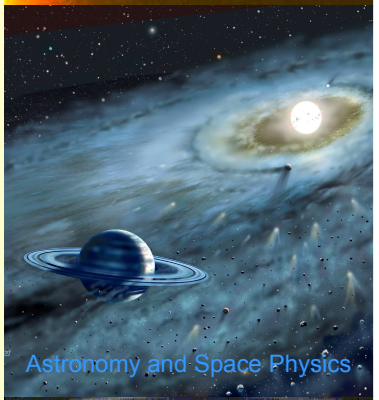
RESEARCH THEMES

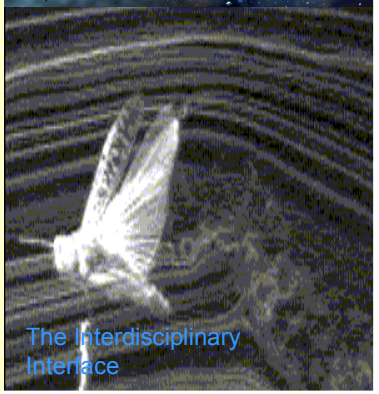
- Bring together Scotland's internationally leading research groups, to attain critical mass.
- Plan strategically at national level, to enable a step change in international competitiveness.
- Recruit world-leading senior researchers and junior fellows.

GRADUATE SCHOOL

- New advanced courses, pooling expertise across Scotland: *improving skills base of young researchers.*
- Prize studentship competition, open to all nationalities: *attracting the brightest and best, worldwide.*
- International Summer Schools and visitor programme: *building on a 40-year track-record*.
- Scotland-wide relay of research seminars and colloquia.


Condensed Matter and Materials Physics


Astronomy and Space Physics


The Interdisciplinary Interface

THE UNIVERSITY OF EDINBURGH

UNIVERSITY of GLASGOW

HERIOT WATT UNIVERSITY

UNIVERSITY of PAISLEY

University of St Andrews

THE UNIVERSITY OF STRATHCLYDE IN GLASGOW

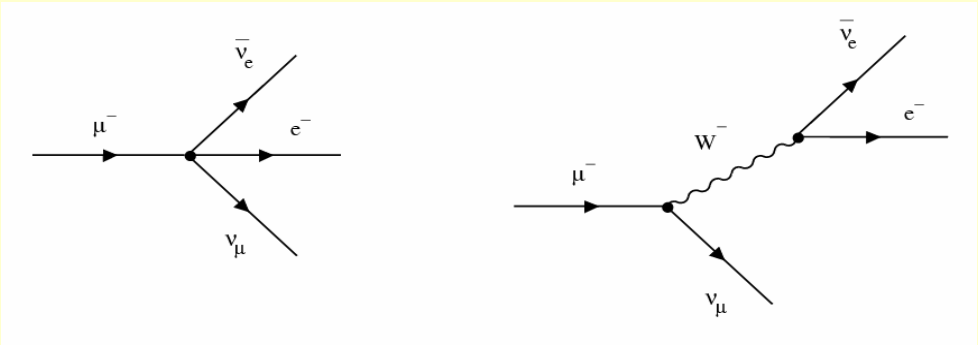
Surely GR is the best theory?

- Simplest theory often best, but remember SU(5)
- Not Machian: rest masses are intrinsic invariants
  - Motivates Brans-Dicke etc.

$$G^{\mu\nu} = -\frac{8\pi}{c^4}\,\phi^{-1}\,T^{\mu\nu}$$

$$\Box\phi = g^{\mu\nu}\phi_{;\mu\nu} = \frac{8\pi}{3+2\omega}\,T^{\mu}_{\mu}(\text{matter}).$$

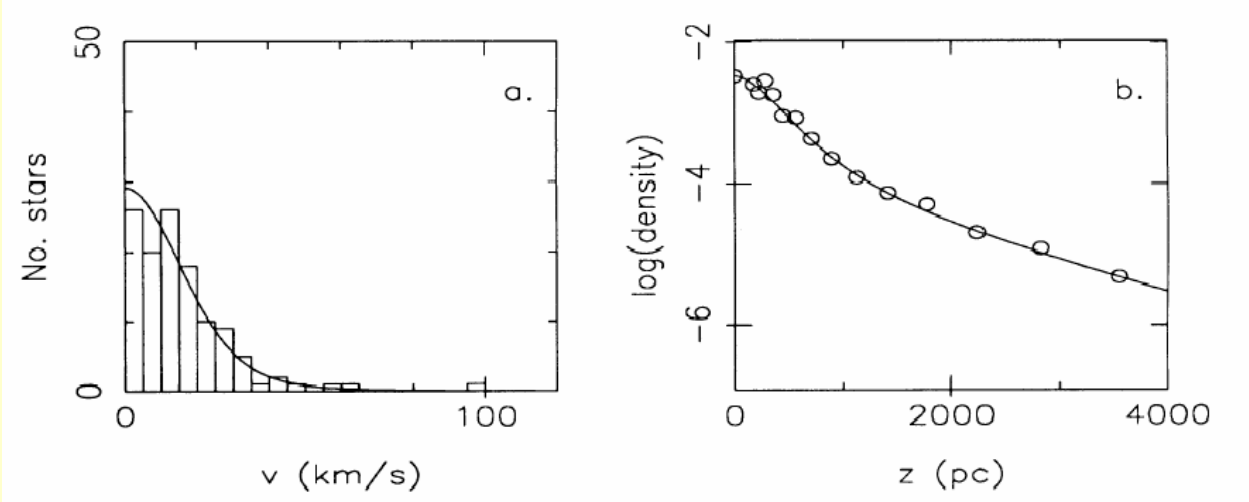
- Not renormalizable: probably GR is an effective theory that changes at high energy (cf. Fermi)



- Specific to 4D: expect effects from extra dimensions (could these be at low energies?)

Surely GR is very well tested?

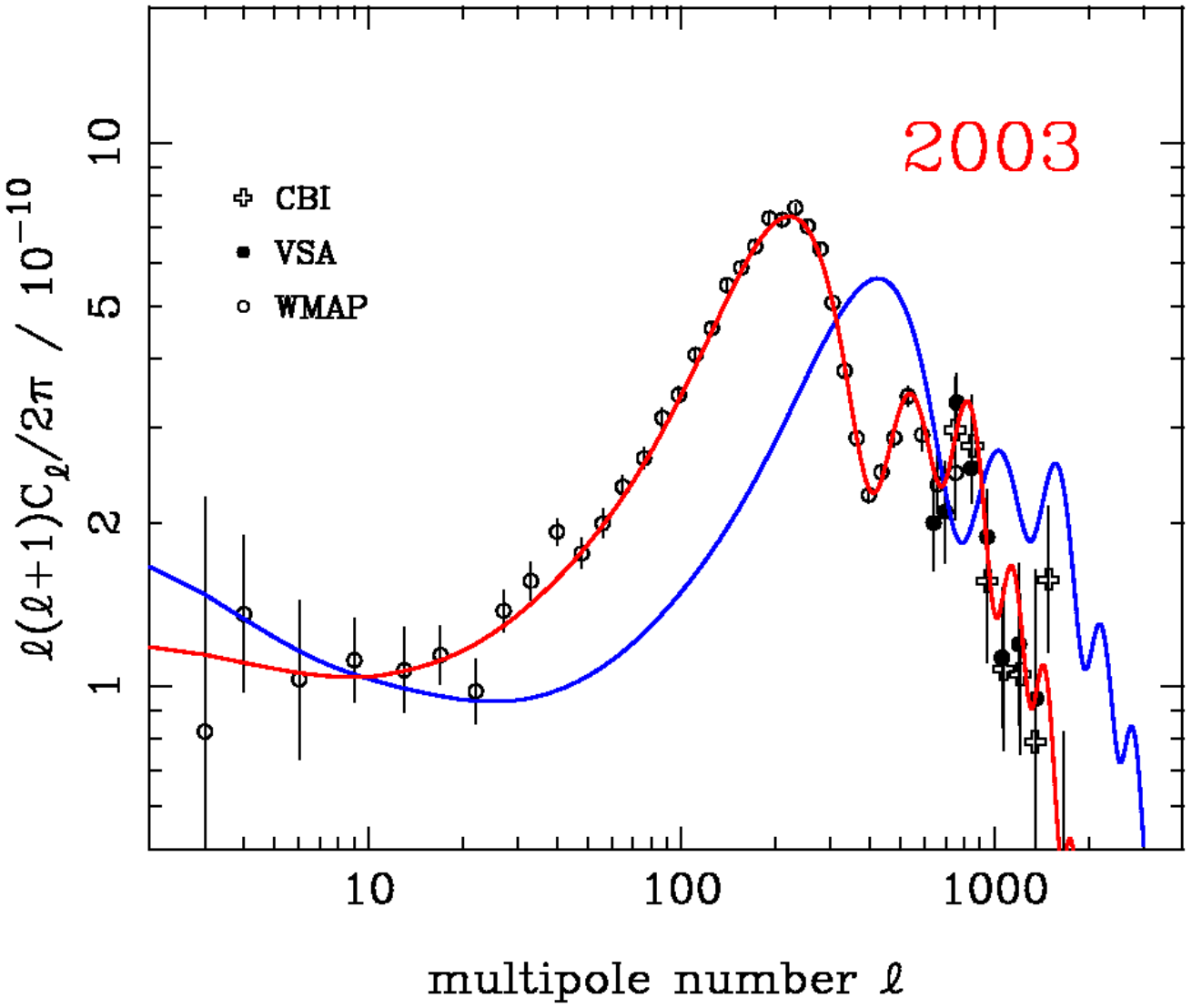
- Earth and (sub-Pioneer) Solar System: 1mm – 6×10^{12} m (Pluto)
- Within Milky Way: pc – kpc scales



Kuijken 1991

- Cosmology: Mpc – Gpc scales
  - Same Baryon:DM ratio from clusters as CMB++ (and consistency with nucleosynthesis)

CMB data evolution



Flat $\Omega_m = 0.3$ (vacuum dominated)

Open $\Omega_m = 0.3$ (no vacuum)

Prejudice

- Standard gravity works well on almost all scales
- There will always be outliers
- There is lots we don't understand (or can't predict) about galaxy formation