

Relevance of the Equivalence Principle

- GG target: EP test to 1 part in 10^{17}
Improvement by 5 orders of magnitude
Same target as STEP (ESA M2 and M3; both more expensive than GG by at least a factor 7)
- Do bodies of different composition fall with the same acceleration in a gravitational field?

$$\frac{\Delta a}{a} \neq 0 \Rightarrow \text{Universality of Free Fall does not hold; EP violated}$$

A Founding Principle (Hypothesis) of General Relativity

- Unique to Gravity
- No EP holds for all other fundamental forces of Nature
- Nearly all attempts to unifying gravity with these forces require EP violation
- EP tests are by far the most sensitive low energy probes of this new physics

$$\frac{\Delta a}{a} < \bar{\gamma} = \gamma - 1 \quad \text{post-newtonian deviations from general relativity}$$

(γ Eddington parameter)

$$\uparrow 10^{-5} \div 10^{-3} \quad \text{depending on scalar or vector models}$$

$$\frac{\Delta a}{a} \leq 10^{-12} \quad \text{from best EP ground tests} \Rightarrow \bar{\gamma} < 10^{-7} \div 10^{-9}$$

Much better than with post-newtonian tests !

- EP is fundamental: all other tests check specific predictions of GR, not its founding hypothesis
- General Relativity may not be the final truth, just as Newton's theory was proved by Einstein not to be the final truth at the beginning of this century

No precise target is predicted at which violation should occur; EP violation is expected but only below the 10^{-12} level reached on Earth, probably well below this level. Only a space experiment can provide it.