Euclid theory working group
~ Marseille presentation

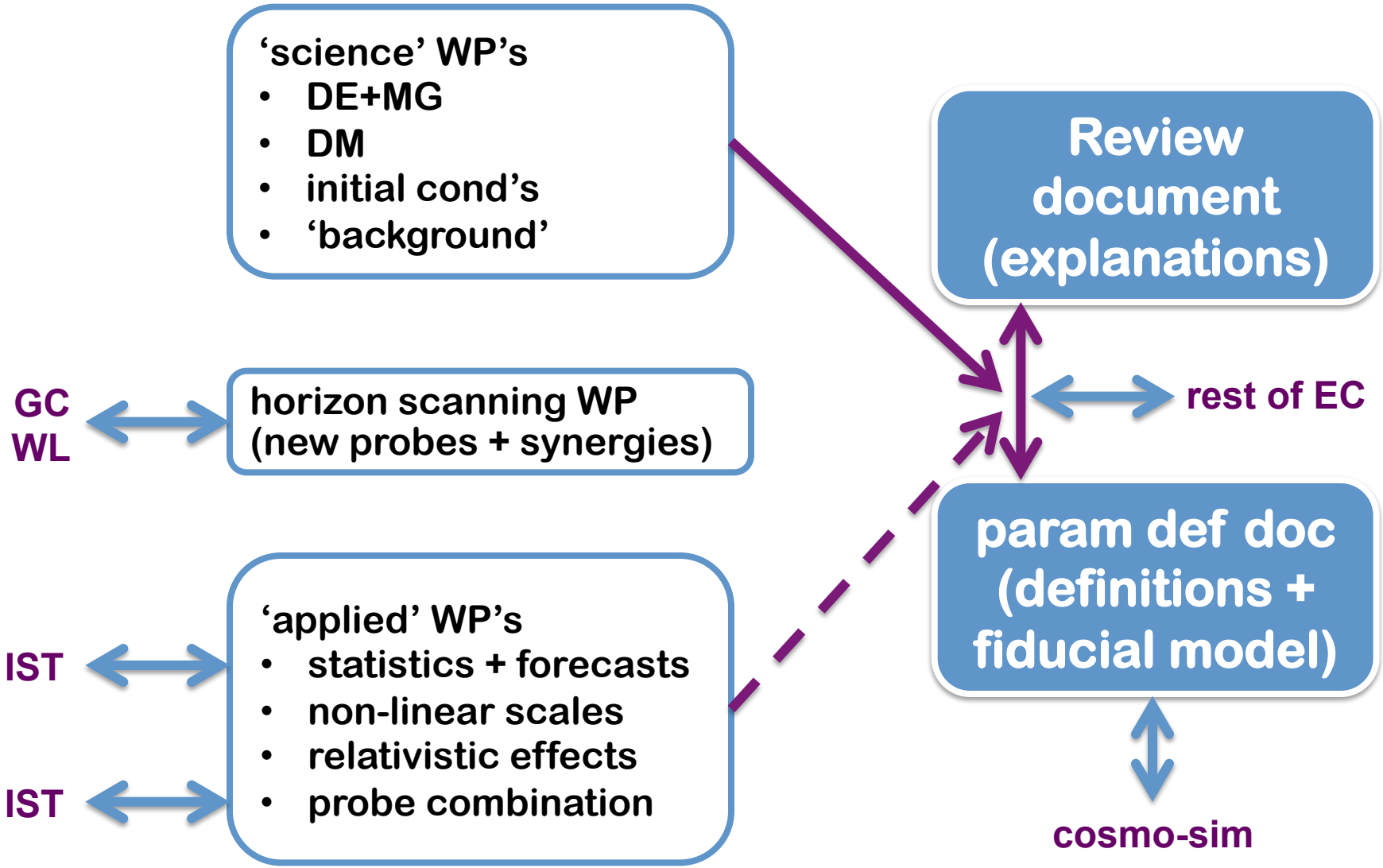
Task of theory WG:

- provide **vision** for the future direction of mission
- forecast which will be the main **questions** in 5+ years, set up framework to answer those questions
- help with **calculations, optimisation and forecasts (additional "beyond-standard" parameters)**
- motivate/inform/support **numerical simulation** effort
- Investigate advanced statistical tools
- Propose additional science

Theory SWG

- over 100 members
- Coordinators: Luca Amendola and Martin Kunz, deputy Matteo Viel
- Wiki on Redmine euclid.roe.ac.uk
- mailing list: euclid-theory@unige.ch
- telecon: Teamspeak
  - Mondays at 5pm CET
  - see wiki front-page for details
  - work packages have separate telecons
- next meeting: January 2015 in Oslo
  (plus param def doc working meeting this summer)

Logical TH-SWG structure



TH-SWG status

- **Review document**
  - arXiv:1206.1225 (60 authors, 200+ pages)
  - published: Living Rev. Relativity 6 (2013), 6
  - bi-annual new releases, new cycle under way
  - editor in chief: Valeria Pettorino
- **Parameter definition document**
  - defines cosmological parameters in model context, including fiducial values
  - links to review doc, forecast & sim docs
- **Work packages**
  - key entities for TH-SWG work
  - links to IST's & other SWG's, update review doc

List of WP's

- 1+2: Dark energy & testing gravity **(Ferreira, Bean)**
- 3: Dark Matter and Particle Cosmology **(Kitching, Camera)**
- 4: Initial conditions (inflation, non-gaussianity etc) **(Desjacques, Germani)**
- 5: Deviations from homogeneity and isotropy **(Garcia-Bellido, Marra)**
- [statistical methods and forecast support **(Pettorino)**]
- 7: analytical approaches to non-linearities (incl. baryon physics) **(Mota, Christopherson)**
- 8: combining different probes **(Blanchard, Carbone)** → IST
- 9: Relativistic effects in observations **(Bonvin)**
- 10: New observational probes **(Martins)** → shared GC/WL
- 11: Review document **(Pettorino, Baker, Camera, Majerotto, Vollmer)**
- 12: Parameter definitions document

a bit of science … ☺

Origin of acceleration:

- Cosmological constant or vacuum energy?
- Simple scalar field “Quintessence” ?
- Modified gravity ?
- Non-linear effect ?

a bit of science … ☺

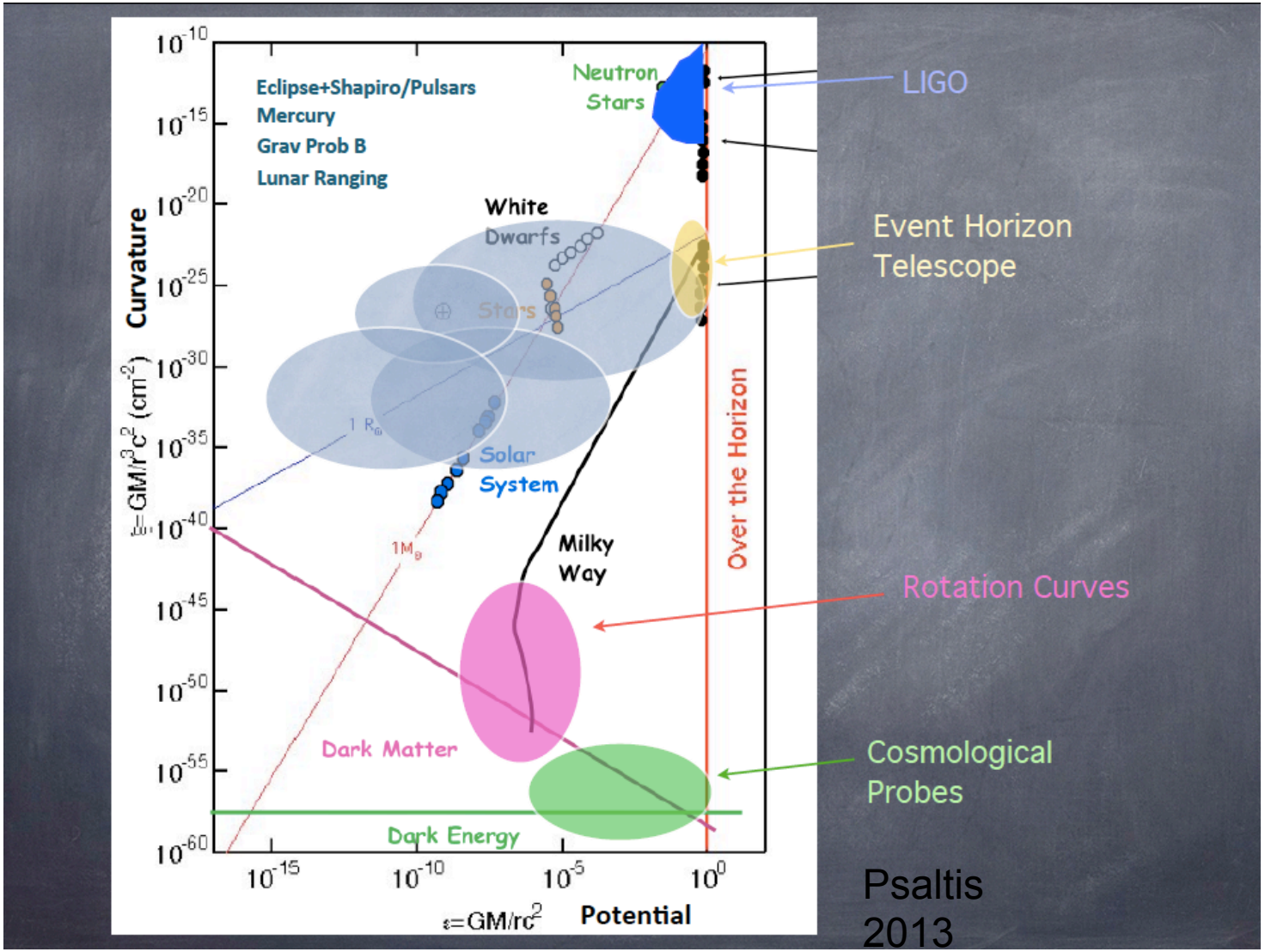
key questions:

- how do we test GR with Euclid?
- how can we distinguish dark energy from a modification of General Relativity?

and many more!

- nature of dark matter, **neutrino masses**, isotropy and homogeneity of the universe, initial conditions / inflation, varying constants, …

A machine to test general relativity



A machine to test general relativity

An example: Jordan-Brans-Dicke Theory
(a time varying Newton constant)

$$S = \int \sqrt{-g} d^4x \left[\phi R - \frac{\omega}{\phi} (\nabla \phi)^2 \right]$$

Now: $\frac{1}{\omega} < 1 \times 10^{-4}$ Solar System (Cassini)

$\frac{1}{\omega} < 6 \times 10^{-3}$ Avilez & Skordis arxiv:1303.4330

Comparable but …
… on length scales 10^{15} time greater!

Euclid: $\frac{1}{\omega} < 3 \times 10^{-4}$ (RSDs only) Baker, Ferreira & Skordis, arxiv:1310.1086

dark energy vs modif. of GR

if Euclid sees a deviation from the standard model, how will we know whether it is 'dark energy' or a 'modification of General Relativity'?

Theory

- GR-like theories have two 'gravitational potentials', ϕ and ψ
- in GR $\phi = \psi$ (with very small corrections)
- $\phi \neq \psi$ indicates
  - either time-varying Newton constant
  - or gravitational wave speed ≠ speed of light

Euclid

- weak lensing measures $\phi+\psi$
- redshift-space distortions measure ψ

Amendola, Kunz, Motta, Saltas, Sawicki, arXiv:1012.3171, 1210.0439, 1305.0008

Euclid is a fundamental physics experiment!

- Euclid is not only a **cosmology** and **astrophysics** mission, it can test **fundamental physics** on length-scales only accessible in this way
- But of course Euclid will also revolutionize cosmology and astrophysics
- Details soon in a new revision of the **theory review document**…