Astro/Cosmo/Gravity Group

TH Retreat 2016

Our mantra

the Universe is the ‘poor man's accelerator’

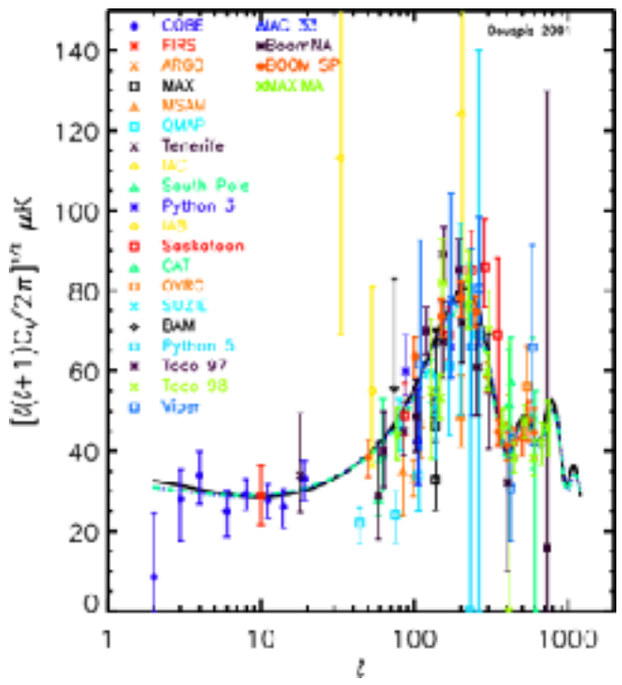
Zel’dovich

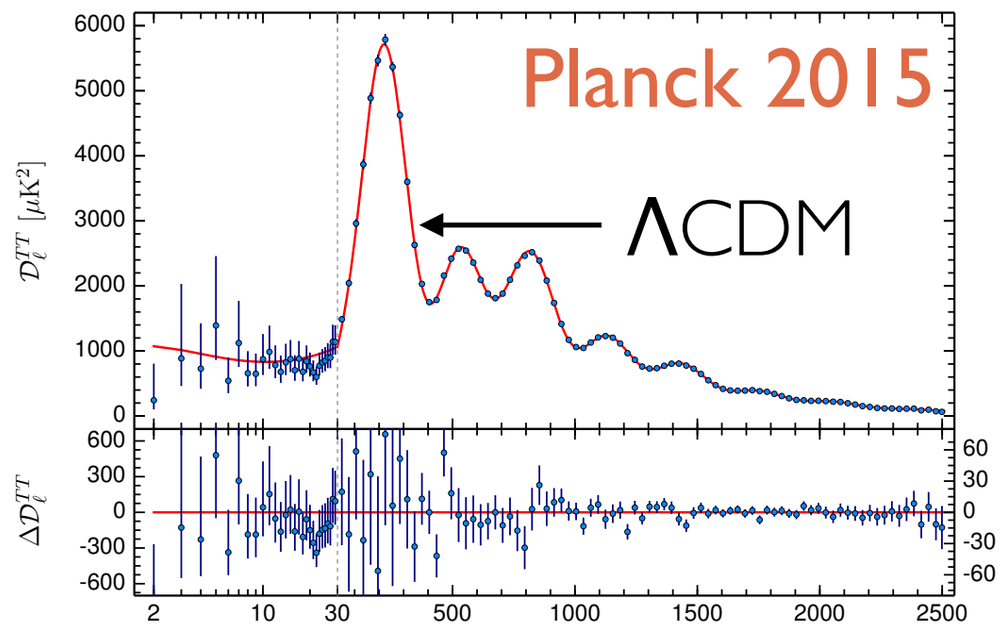
Fundamental physics from free* data

*once you build the detector

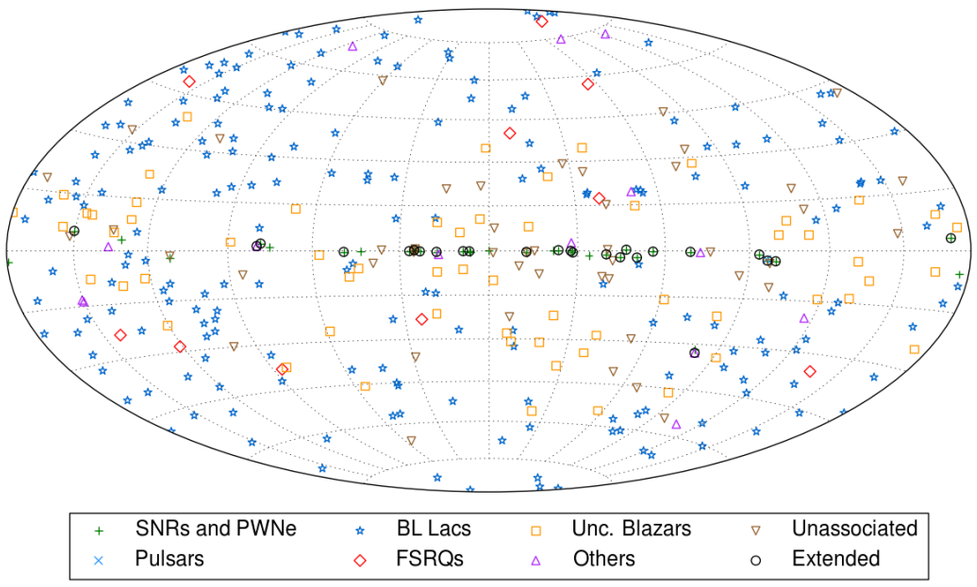
Times, they are A changin'

CMB

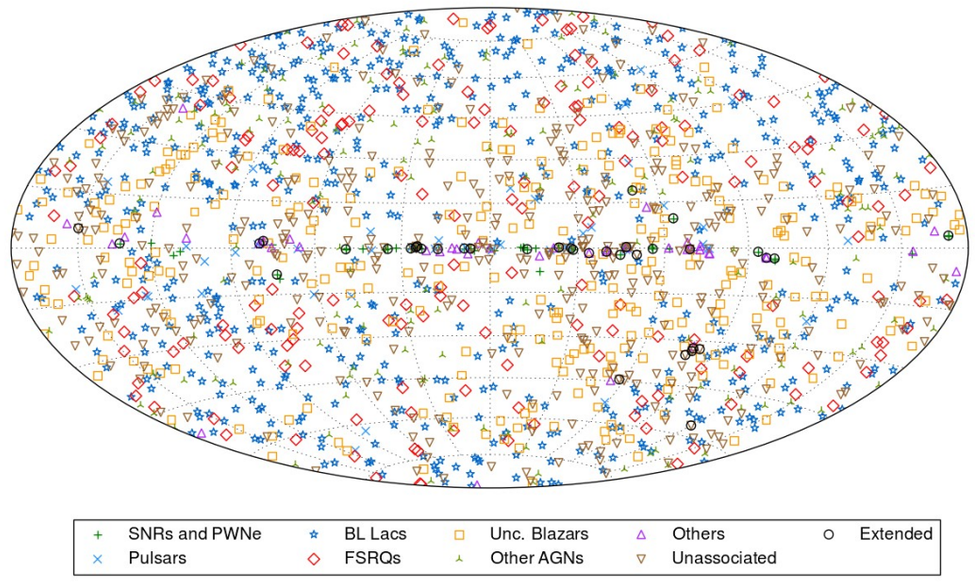




Gamma Rays sources



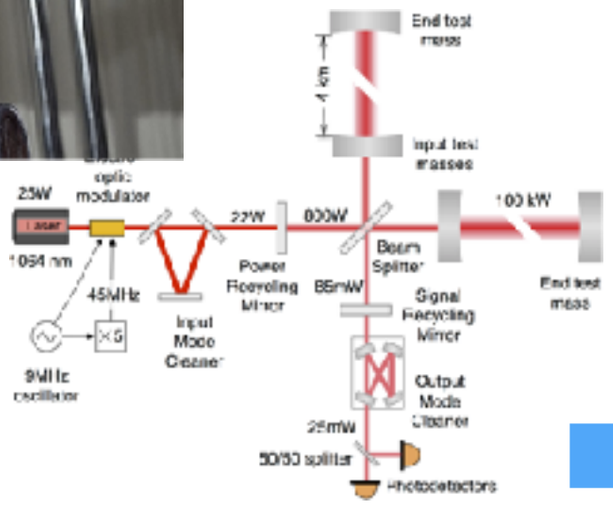
Fermi (from TeVPA16)

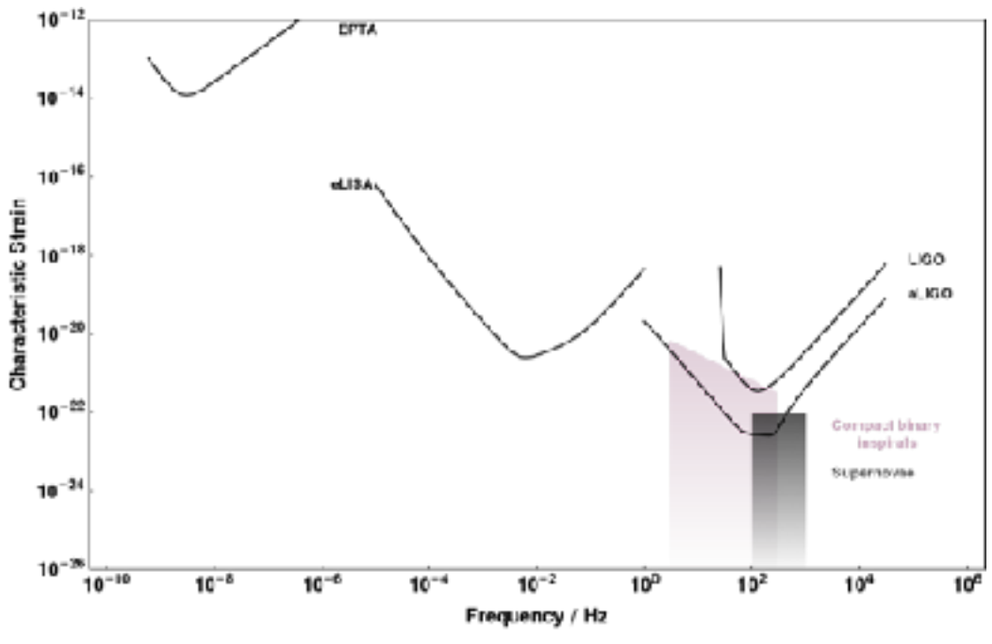


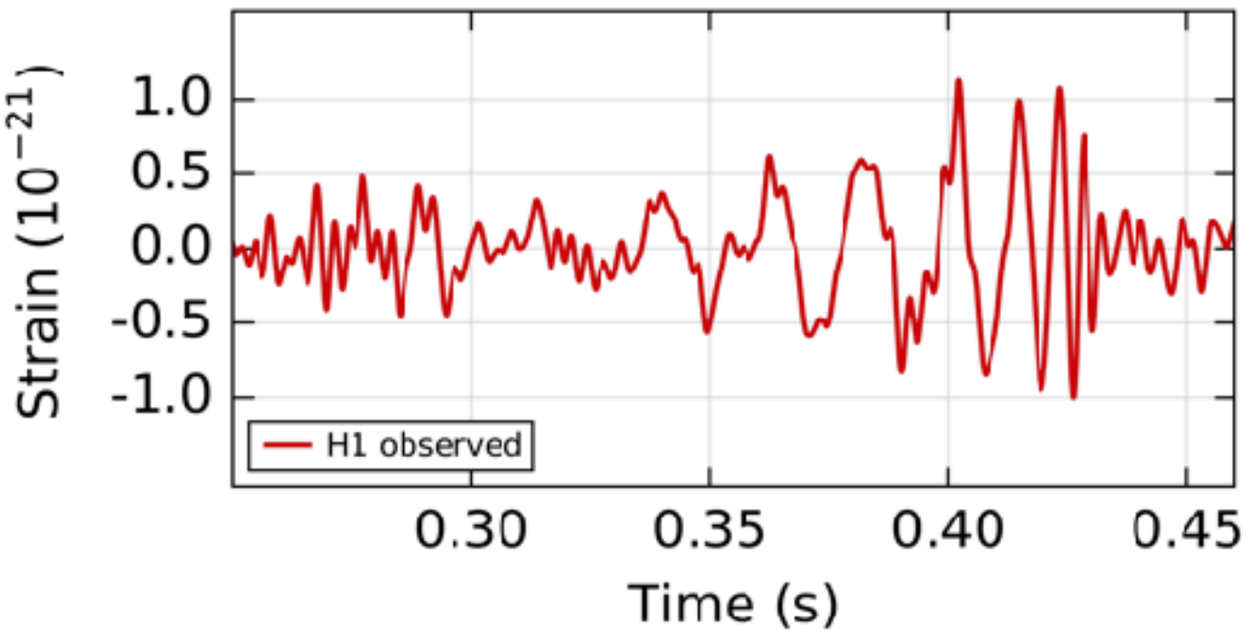
Times, they are A changin'

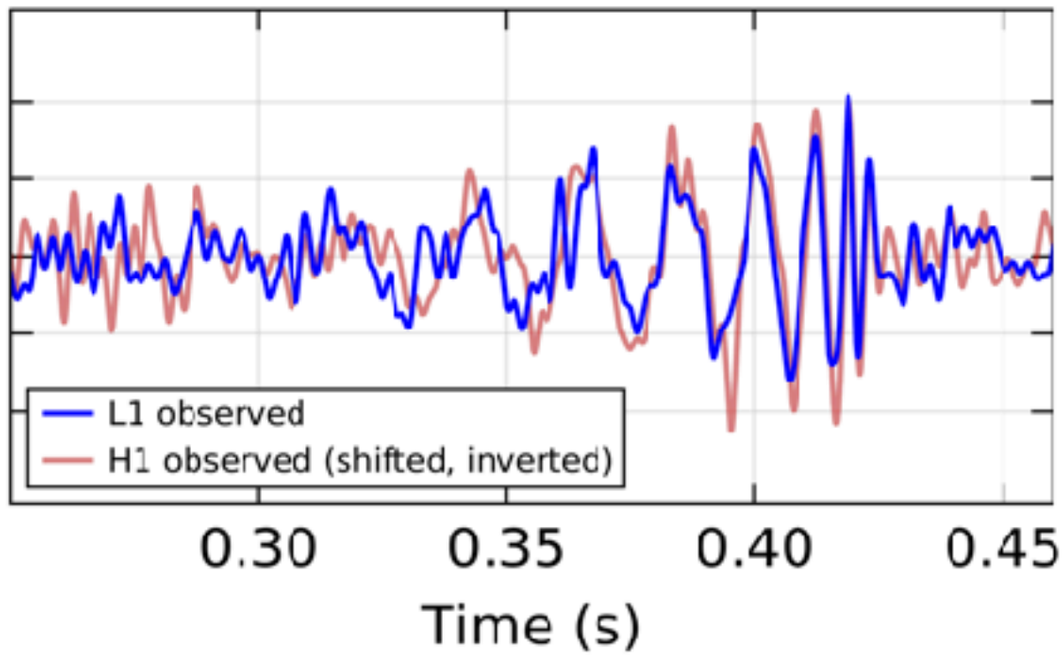
aLIGO 2016

Gravitational Waves









El Dorado of data

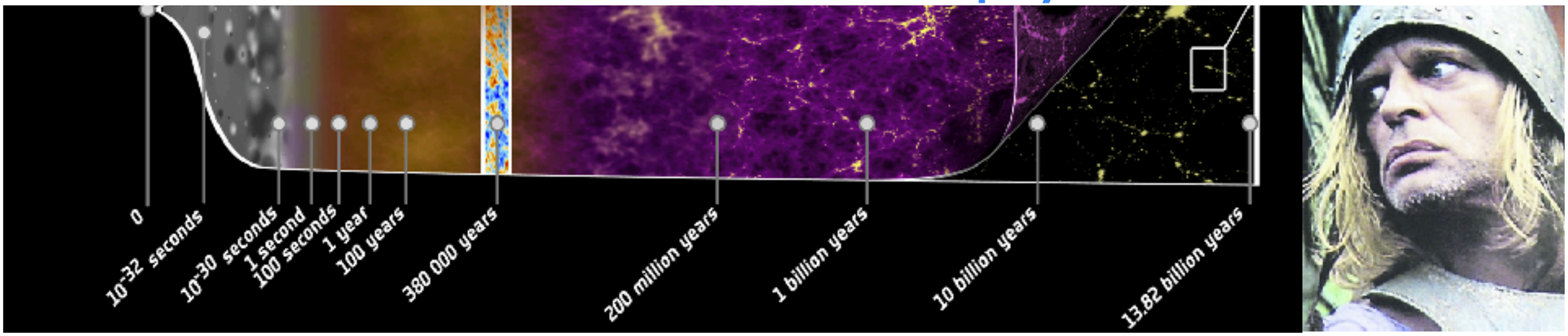
today: moving towards multimessenger

- CMB (temperature anisotropies, polarization anisotropies)
- Large scale structure (galaxy surveys, weak lensing)
- Gravitational waves (2 1/2 public events)
- Wealth of astronomical/astroparticle data (halo profiles, X-ray, γ, cosmic rays, neutrinos, Gaia,…)

future: explosion in quality and amount of (multimessenger) data

- CMB (spectral distortions?, polarization?)
- Many new surveys of galaxies LSST, DES, Euclid…and 21 cm
- Gravitational waves: aLIGO/Virgo, LISA (2030)
- Impossible to summarise: CTA, SKA, IceCube, more Gaia, more Fermi, HAWC, AMS02,…

Which fundamental physics?



composition, initial conditions, and evolution

dark matter

dark energy

neutrinos

gravitation (B)GR

(B)SM in the sky

inflation

defects

reheating

phase transitions

baryogenesis

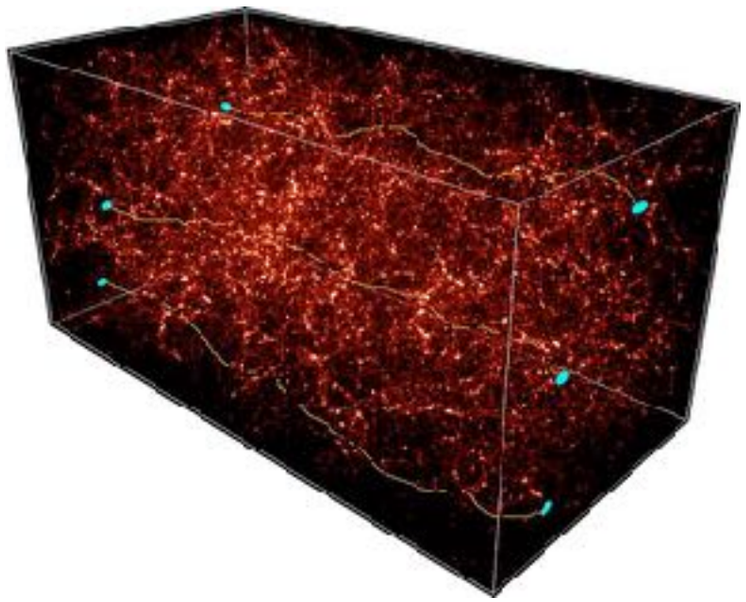
Big Bang Nucleos.

CMB

large scale structure

compact objects

gravitational dynamics



DM evolution example

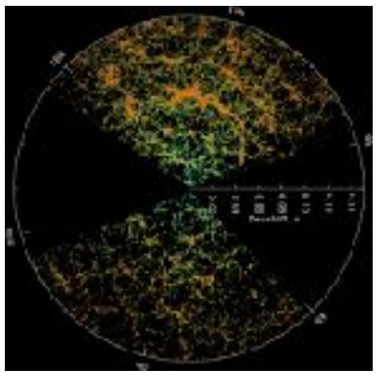
Control and exploit the relation between the observed signal and "fundamental" quantities

Methods

Analytical

Numerical

Large scales:



statistical description:
correlation functions

'perturbatively' close to Gaussian:
methods from statistical field theory
(resummations, EFT ideas…)

Smaller scales:

gravity destroys Gaussianity and
generates non-perturbative objects (halos)

more phenomenological models
(e.g. halo model)

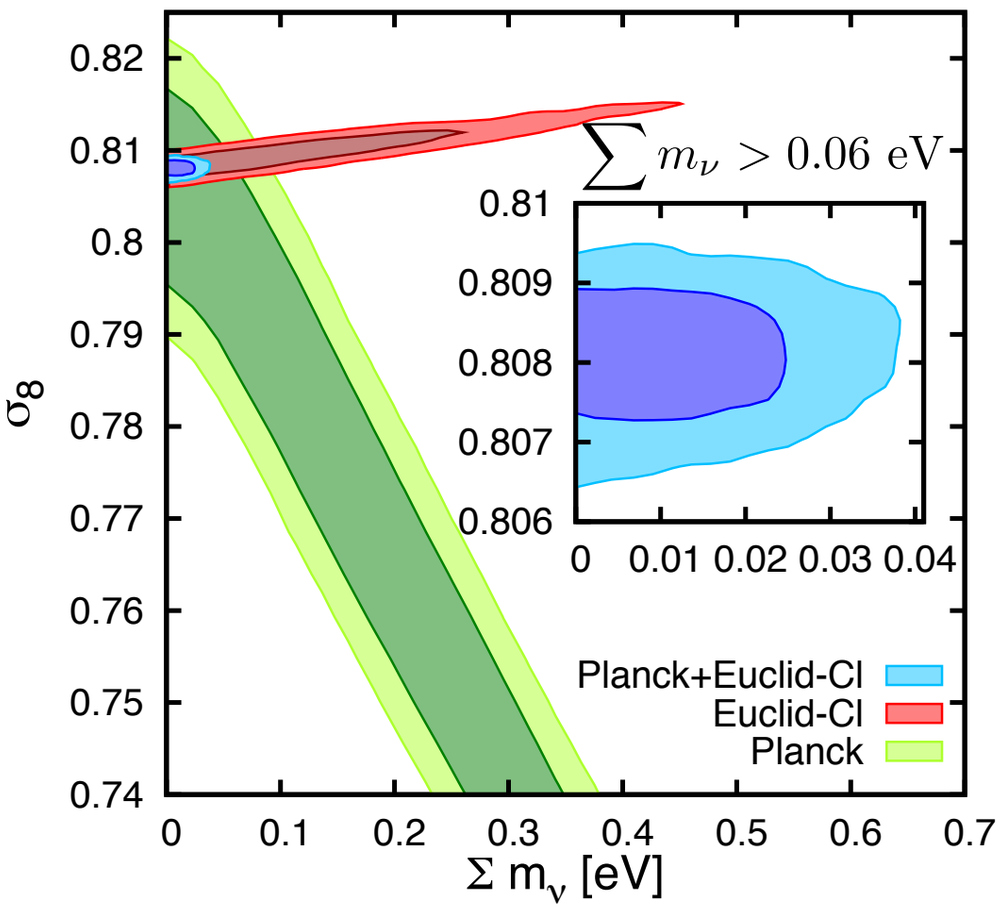
N-body simulations

Goal: tune analytics to N-body and extract parameters

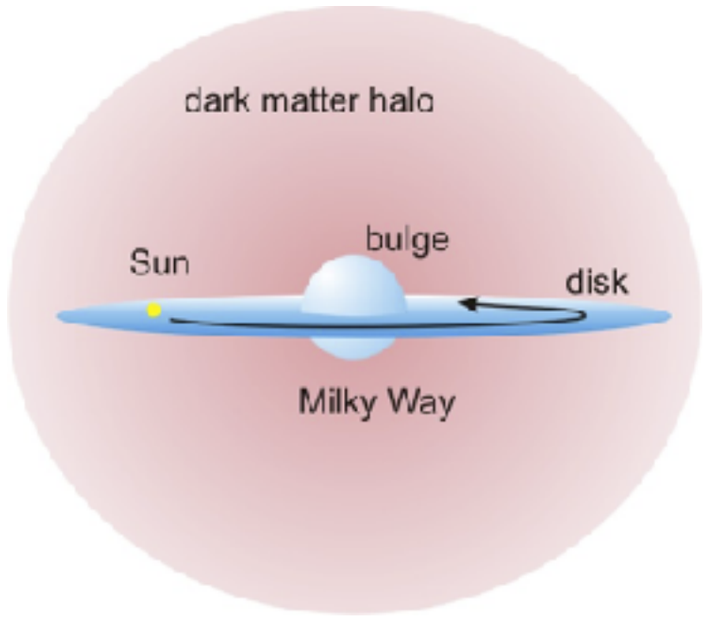
DM evolution example: products

i) Matter distribution at different times

sensitive to inflation (fNL), DM properties (WDM, 'axionic', SIDM, annihilating…) and neutrino properties (masses)



ii) Dark matter profiles in galaxies



Sensitive to DM properties

Crucial for Direct and Indirect detection

Can it affect local dynamics?

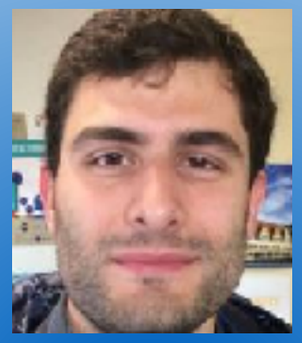
'Dirty' physics in both cases from SM component…

Staff

Sergey Sibiryakov
(EPFL/CERN)

Diego Blas

Fellows



Guido D'Amico

Dani Figueroa

Ji-Haeng Huh

Diana Lopez-Nacir

Paolo Panci

Wessel Valkenburg

Jacobo López-Pavón

Tien-Tien Yu

Alfredo Urbano

Alberto Salvio

Associates (2016/early 2017)

Vitor Cardoso

- binary **black hole merger**: ringdown stage and tests of no-hair results and theory of gravity using this phase.
- **GW** signatures beyond GR: emphasis on light bosonic fields. Superradiance consequences in LIGO LISA science. Two-body problem with bosonic black hole **hair**.
- Interaction between black holes with environment

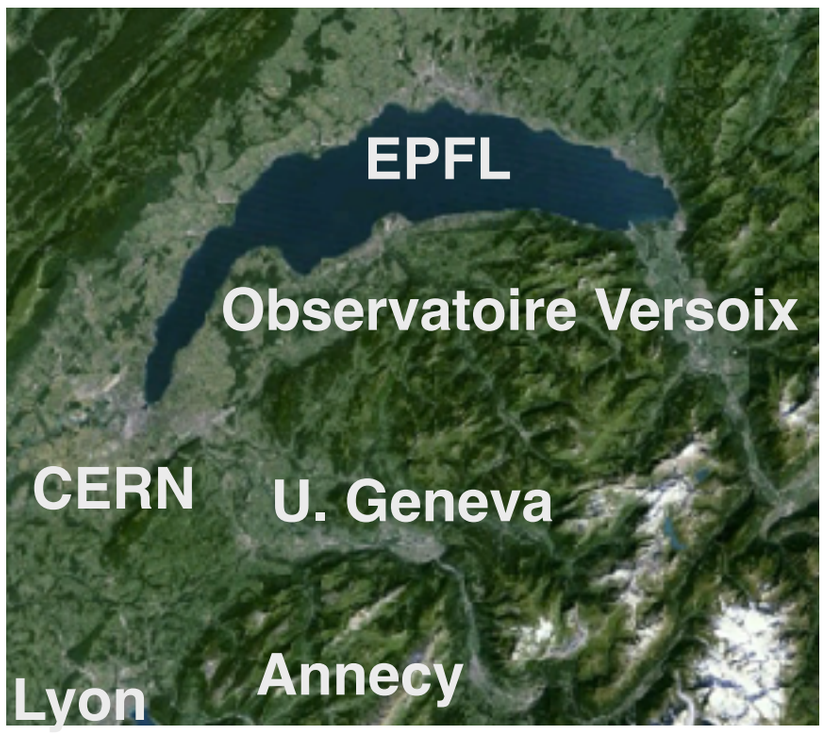
Alex Kehagias

- **dS/CFT** applied for correlators during inflation.
- Asymptotic symmetries in cosmology and **soft-theorems**
- Holographic description of **large scale structure**.
- Supersymmetry and **Supergravity** (broken SUSY by constraint superfields and application to cosmology)

Alexey Boyarsky

- cosmology and particles physics of the **nuMSM,** SHiP physics, dark matter (astroparticle/cosmology aspects)
- **chiral MHD** in cosmology, astrophysics and other systems.
- Leader of ScienceWISE.info .

Activities



CosmoCoffee Weds@11:30
Informal seminar on
Astro/Cosmo/Gravity

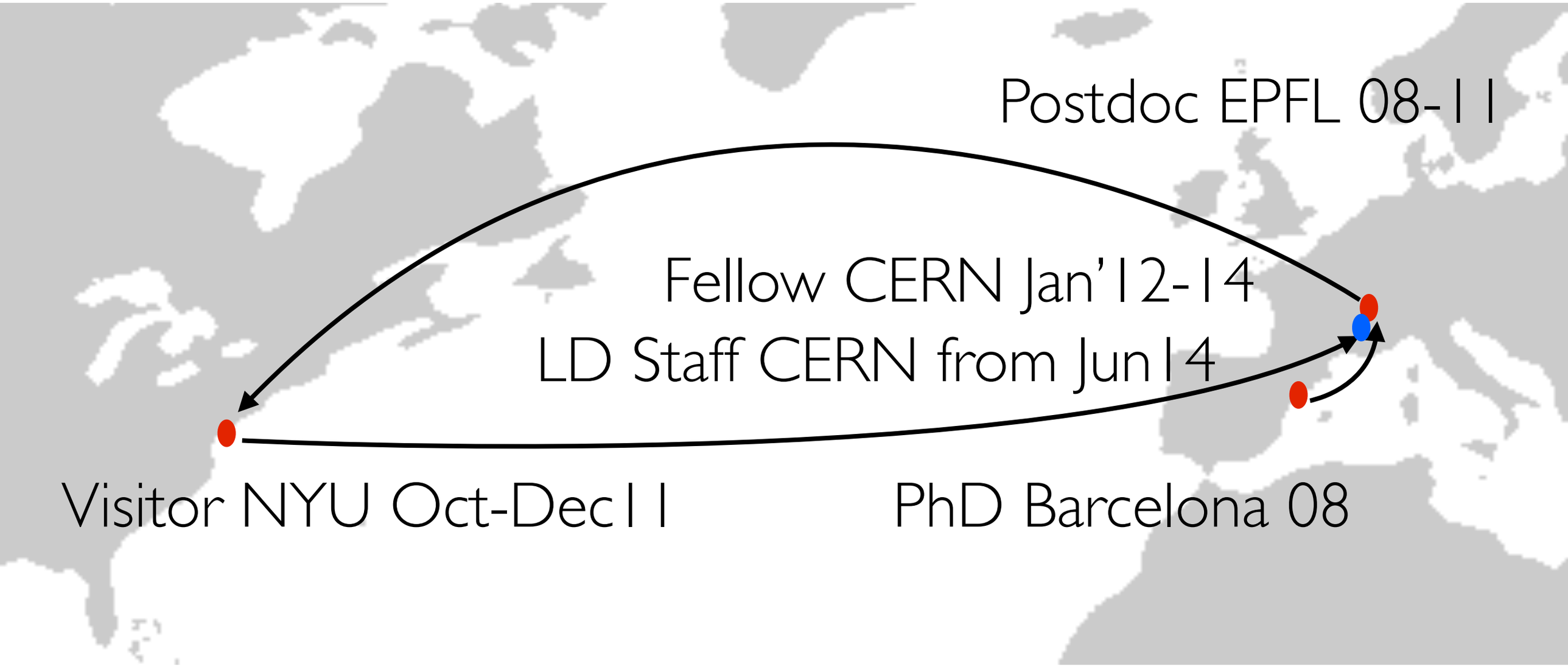
ECU Meetings

Every month and 1/2 (next 11th Nov)
Joint journal-club with
different Astro/Cosmo/Gravity
groups around Lake Léman

TH-Institutes 16

Emergent Properties of Space-Time (w/ Lattice/Formal)
The Big Bang and the Little Bangs (w/ HI)
Neutron stars (dec. 16) (w/ HI)

About myself: Timeline



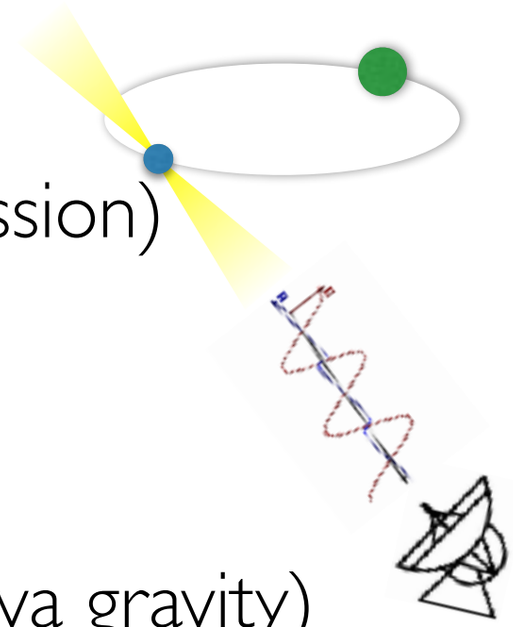
what I do: playing w/ gravity

* Analytical studies DM structure formation at large scales

Tools beyond standard perturbation theory
Models beyond ΛCDM: primordial NG, neutrino masses, light DM

* Astrophysical tests of gravitation

With cosmological and pulsar data (GW emission)



* Pulsar timing to test (light)DM/BSM

* Quantum gravity w/o Lorentz invariance (Horava gravity)

1-loop effective action, black holes

Lorentz invariance as an emergent low-energy symmetry

other interests weakly interacting backgrounds

summer students

Students (3rd-5th year) come for 2 months every summer

You can propose a project with a staff member (mid Jan)