

# Theoretical cosmology research in Finland

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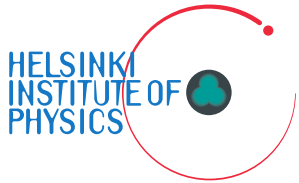
Department of Physics and

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# Cosmology at the crossroads

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## Theory

- Cosmology
- Astrophysics
- Particle physics

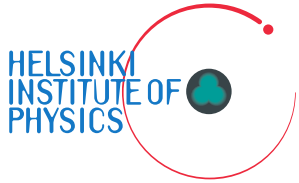
## Observations

- Planck (2009)
- Euclid (2020)
- Others: COrE (2029?), eRosita, 4MOST, SDSS-IV, AS4, COSMOS, MOSAIC/E-ELT



# Four cities

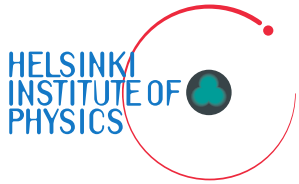
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- Theoretical cosmology research is carried out in Helsinki, Jyväskylä and Turku.
- Involvement in Planck/Euclid also at Aalto University.



# Researchers by field and city



	Staff	Postdocs	PhD students
Cosmology	8.2	5.5	15
Astrophysics	5	2.5	6
Particle physics*	5	6	7
Total	18.2	14	28

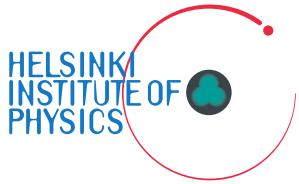
\* Fraction of research time spent on cosmology varies between 10% and 100%.

	Staff	Postdocs	PhD students
Helsinki*	8.2	6	12
Jyväskylä	2	1	5
Turku	3	1	4
Total	13.2	8	21

\* Excluding particle physics.



# Research topics

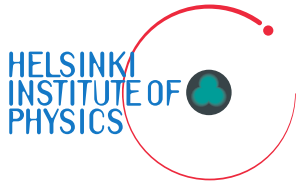


	Cosmo	AP	PP	Total
Late-time acceleration	5/1/1			5/1/1
Modified gravity	4/2/3			4/2/3
Testing basic hypotheses	2/1/0	1/0/0		3/1/0
Inflation	4/1/4		1/0/1	5/1/5
Dark matter	3.2/0/1		3/3/5	6.2/3/6
Phase transitions	1.2/0/1		2/2/0	3.2/2/1
Baryogenesis	1/0/1		3/1/1	4/1/2
Cosmic defects	1.2/1/0		1/1/0	2.2/2/0
Galaxy and cluster obs.		3/1.5/4		3/1.5/4
Galaxy simulations		2/1/2		2/1/2
Focused on Planck/Euclid	3/3.5/2	0/1.5/0		3/5/2



# Planck

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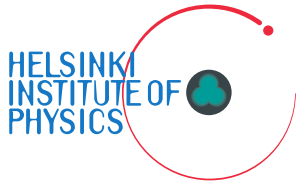


- ESA CMB satellite.
  - Finnish participation started in 1996.
  - Launched in 2009.
  - Stopped taking data in 2013.
  - Final data + analysis due to come out this year.
  - Finland cosmology team led by Hannu Kurki-Suonio.
- Finland involved in hardware, mapmaking and data analysis.



# Planck

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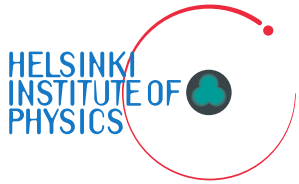


- Planck had HFI and LFI team.
  - Finland was on the LFI team.
- Membership
  - Collaboration has had in total 800 members, including over 40 from Finland (5%).
  - Total 300 Planck scientists, including 15 from Finland. (Helsinki 8, Aalto 3.5, Turku 0.5, Ylinen company 3.)
  - In 2017, 455/251 members/PS's, 12/8 from Finland.



# Planck

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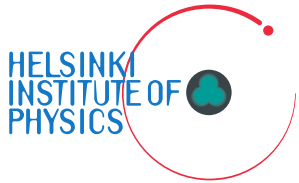
- Hardware
  - One of the three LFI radiometers partly manufactured in Finland.
- Finland Cosmology team
  - Mapmaking
    - Developed the code and the methods for making the LFI temperature and polarisation maps.
  - Data analysis
    - Made simulations for data analysis with the US team, 30 million CPU hours from CSC.
    - Cosmological parameter estimation and model comparison, esp. isocurvature perturbations.





# Euclid

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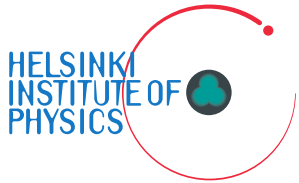


- ESA large scale structure satellite.
  - Selected as an M-class mission in 2011.
  - Due to be launched in 2020.
  - Finland team led by Hannu Kurki-Suonio.
- Science aims: dark energy, modified gravity, dark matter, neutrinos, testing basic cosmological hypotheses.



# Euclid

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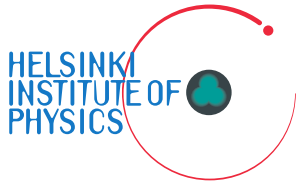


- 1200 members, 25 from Finland (Helsinki 16, Turku 6, Jyväskylä 2, Aalto 1).
- Finland involved in three ways:
  - One of the Science Data Centers will be here, using CSC hardware.
  - Developing data analysis methods.
  - Data analysis. (F. Montanari co-leads the relativistic effects working group.)



# Other observations

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- Finland is involved in COrE.
  - Next generation CMB polarisation satellite.
  - ESA M5 mission proposal, planned for launch in 2029.
  - Preliminary selection in June.
  - Finland team led by Hannu Kurki-Suonio.
- Finland is involved in observational cluster projects via Alexis Finoguenov.
  - PI of cluster survey for 4MOST, also in SDSS-IV, AS4, 4MOST, eROSITA, COSMOS and MOSAIC/E-ELT.