

HERTZ LECTURE.

DESY Lecture on Physics 2021

Cosmology and astrophysics into the next decade

Prof. Matias Zaldarriaga
(Institute for Advanced Study, Princeton)

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18:00 h, talk will be live-streamed

<https://webcast.desy.de>

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Gravitational Waves in the Polarization of the Microwave Background

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Using a particular decomposition of polarization in the cosmic microwave background (CMB) into scalar, vector, and tensor modes, we show that a particular combination of the Q and U parameters vanishes for primordial fluctuations generated by scalar modes, but does not for vector and tensor modes. This result shows that the detection of polarization is not limited by cosmic variance as in the case of temperature fluctuations. Numerical simulations of various polarization power spectra, which are valid on the scales of interest for CMB experiments, show that the expected signal is of the order of the noise level. [S0031-9007(97)02703-8]

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Gravitational lensing effect on cosmic microwave background polarization

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We investigate the effect of gravitational lensing by matter distribution in the universe on the cosmic microwave background polarization power spectra and temperature-polarization cross-correlation spectrum. As in the case of the temperature spectrum, gravitational lensing leads to a smoothing of narrow features and the enhancement of power on the damping tail of the power spectrum. Because the acoustic peaks in polarization spectra are narrower than in the temperature spectrum, the smoothing effect is significantly larger in polarization up to 10% for $l < 1000$ and even more above that. A qualitatively new feature is the generation of B type polarization even when only E is intrinsically present, such as in the case of pure scalar perturbations. This may be directly observed with Planck and other future small scale polarization experiments. The gravitational lensing effect is incorporated in the new version (2.4) of the CMBFAST code. [S0556-2821(98)05214-X]

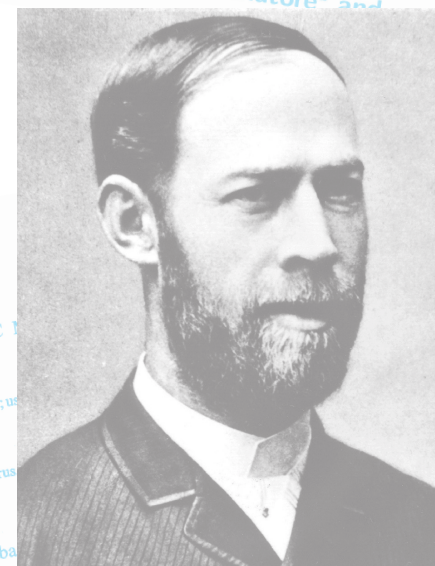
PACS number(s): 98.70.Vc, 98.80.Cq

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Cosmological non-linearities as an effective fluid

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Over the past decades we have seen remarkable improvements in our understanding of the Cosmos. We have been able to determine the composition of the Universe, its age and expansion history with outstanding precision. We have gathered very interesting clues about the initial conditions of the hot Big Bang and developed models that can explain them. We have discovered new phenomena and exotic objects and have been able to use them as tools to learn about Cosmology. This lecture will summarize our current understanding of the properties and history of our Universe and focus on some of the open questions in the field and describe some of the ongoing efforts to try to answer them.



Heinrich Hertz
1857 Hamburg-Karlsruhe-Bonn 1894

ABSTRACT
We present a new method for calculating linear cosmic microwave background (CMB) anisotropies based on integration over sources along the photon past light cone. The geometrical term is written as a time integral over the product of a geometrical term and a cosmological model. The source term can be expressed in terms of photon perturbations, all of which can be calculated using a small number of standard methods. This is achieved because the dynamical from the computational time compared to standard methods. More important, separates us to significantly reduce the computational time compared to standard methods. This is achieved because the source term, which depends on the model and is generally the most time-consuming part of calculation, is a slowly varying function of wavelength and needs to be evaluated only in a small number of points. The geometrical term, which oscillates much more rapidly than the source term, does not depend on the particular model and can be precomputed in advance. Standard methods that do not separate the two terms require a much higher number of evaluations. The new method leads to about 2 orders of magnitude reduction in CPU time when compared to standard methods and typically requires a few minutes on a workstation for a single model. The method should be especially useful for accurate determinations of cosmological parameters from CMB anisotropy and polarization measurements that will become possible with the next generation of experiments. A program implementing this method can be obtained from the authors.

