## **School of Mathematics**

Course 442 - General Relativity and Cosmology (Optional JS & SS Theoretical Physics, JS & SS Mathematics)

Lecturer: Conor Houghton

**Requirements/prerequisites:** 211, 221, 241

Duration: 21 weeks.

Number of lectures per week: 3

Assessment:

End-of-year Examination: One 3-hour examination

**Description:** This course gives an introduction to relativity and cosmology. There is a course web site with problem sheets, recommended texts, notes and a lecture by lecture account of the material given.http://www,maths.tcd.ie/~houghton/442.html

**General Relativity** Mathematical background tensors, covariant derivatives, geodesics, Killing's equation, the Riemann tensor, physical meaning of the Riemann tensor. The Einstein equation and general relativity the Einstein equation, the cosmological constant, the weak field limit, the Schwartzschild geometry, the bending of light by the sun and the perihelion of Mercury. Field theory methods the Einstein-Hilbert action and the vacuum Einstein equations, the introduction of matter and the unified action.

**Cosmology** Introduction description of the universe, the assumptions of cosmology, Obler's paradox. Robertson-Walker metric the Robertson-Walker metric, the RW-Freidman equations and their solutions for a dust universe and for a flat radiation universe, discussion of mixtures, the age of the universe, the flatness problem. The cosmological constant including the cosmological constant, de Sitter space, cosmological evolution, the age of the universe. the Hubble law for red-shift, q. Inflation the inflaton, slow-roll inflation.

**Special Topics** *Gravitational radiation* the linearized Einstein equations, the harmonic gauge, plane waves, counting the polarizations for plane waves. *Kaluza Klein theory* Kaluza-Klein theory, reducing general relativity on Kaluza-Klein space-time to four-dimensions, momentum as charge, vacuum solutions.

April 9, 2003

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