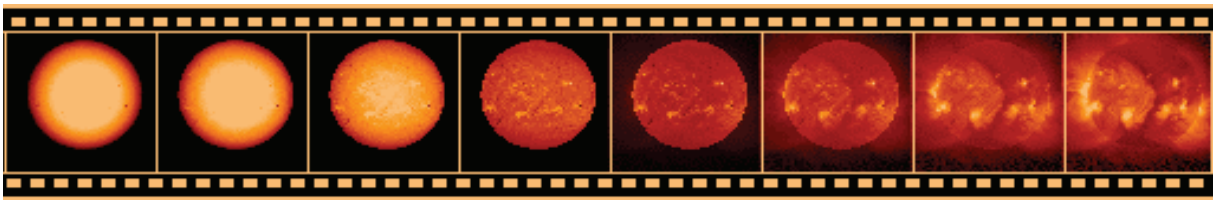
DIPARTIMENTO di FISICA e ASTRONOMIA "Ettore Majorana"

UNIVERSITÀ degli STUDI di CATANIA



INTRODUCTION TO WAVES AND OSCILLATIONS

for MSc or PhD students in maths, physics (incl. astron/astrophys)

Prof. R. Erdélyi (Eötvös University, Budapest)

email: robertus@sheffield.ac.uk

LINEAR AND NONLINEAR WAVES

[BASIC MODELLING OF WAVES ON STRINGS, SURFACES, WATER/PLASMA WITH APPLICATIONS]

Schedule: 24, 25, 26, 27, 28 Feb - 2, 3 Mar 2020

Time: 15:00 - 17:00

Location: Classroom L, Dept of Physics and Astronomy, University of Catania

Part 1: Linear and nonlinear waves in fluids

- Examples of waves in nature; Waves on a stretched string; derivation of governing PDE; kinetic, potential energy; D'Alembert's GS, solution for strings of infinite length Heaviside fnc, 2 examples
- Standing waves on a string on a finite length, standing waves, normal modes, method

of separation of variables, plucked string (example: triangle initial profile); Mode energy, Fourier transform, 2D wave equation, Bessel equation, Bessel's solution

- Plane waves, sound waves (3D wave equation), eq of continuity, velocity potential; Acoustic waveguides
- Linear inviscid/viscous water waves, incompressible fluids, governing equations (Laplace eq, Bernoulli eq), kinematic BC, monochromatic surface waves, DR, limits (shallow & deep water) concept of group velocity, wavepacket, particle path in surface waves
- Quasi-linear 1st order PDEs, associated equation, characteristics, 2 examples, properties of characteristics, discontinuities (weak, strong), shocks, jump condition
- Modelling traffic flow (example: break down time), kinematic wave, Riemann problem, Burger's equation, Hopf-Cole transformation, diffusion eq.

Part 2: Linear MHD waves

- MHD equations (ideal), limits of MHD, MHD equilibria, force free field, potential field
- Linear MHD waves in homogeneous media: Alfven waves (circularly polarised), slow and fast MHD waves, Fridrich's diagram, characteristics in ideal MHD
- Internal gravity waves, acoustic-gravity waves MHD waves at a single magnetic interface
- MHD waves in magnetic slabs: gov. eq., Dispersion Relation, classification of modes MHD waves in magnetic flux tubes (infinite): gov. eq., DR, modes
- MHD waves in thin flux tubes (gravitational stratification), Klein-Gordon equation (sound, slow and Alfven)
- Observations of MHD waves and oscillations in nature