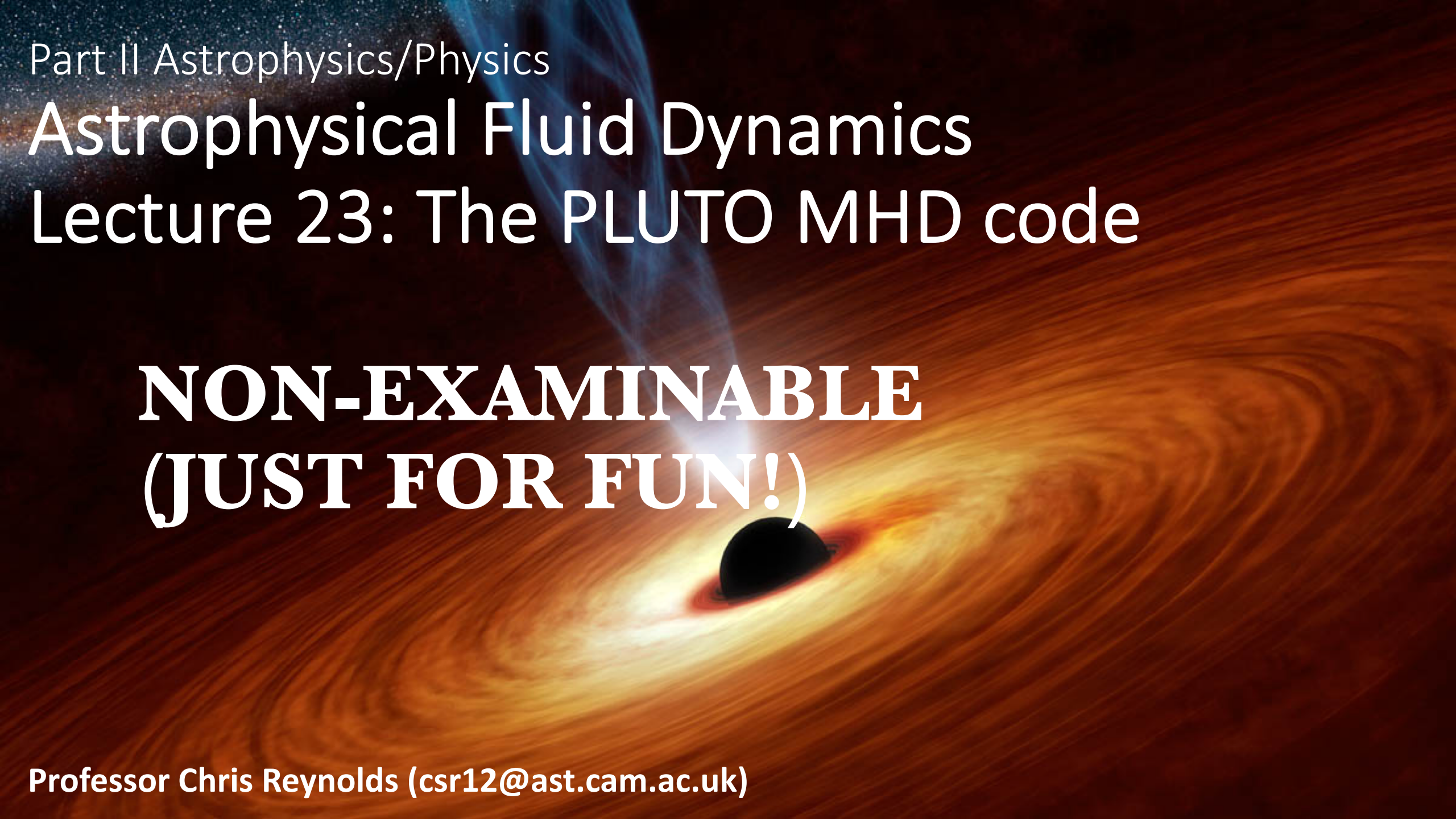
Part II Astrophysics/Physics

Astrophysical Fluid Dynamics
Lecture 23: The PLUTO MHD code



NON-EXAMINABLE
(JUST FOR FUN!)

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This Lecture

- A quick “how to” guide on Computational Fluid Dynamics
- PLUTO Magnetohydrodynamic Code
  - Downloading and configuring
  - A walk through the input files
  - Compiling the code
  - Running the code
- Some examples of single-CPU simulations…
  - Blast wave
  - Wind tunnel
- Next Lecture – visualization and parallel simulations

PLUTO

- Powerful, flexible code for astrophysical fluid dynamics
- http://plutocode.ph.unito.it
- Characteristics
  - Grid-based code (solved equations in Eulerian picture)
  - Solves conservative forms of mass, momentum and energy equations
    - Given appropriate boundary conditions, conserves this quantities “exactly”
  - Can use cartesian, cylindrical polar or spherical polar coordinate system
    - Can also “stretch” coordinate grids as necessary/useful
  - Modular code; can turn on additional physics as needed
    - Cooling, viscosity, conductivity, MHD, (special) relativity, radiation transport
  - Use in single CPU mode, or (massively) parallel mode
  - Written in C (so is a fast, compiled code)

- General requirements
  - C compiler, GNU make, python
  - MPI library (for parallel runs)

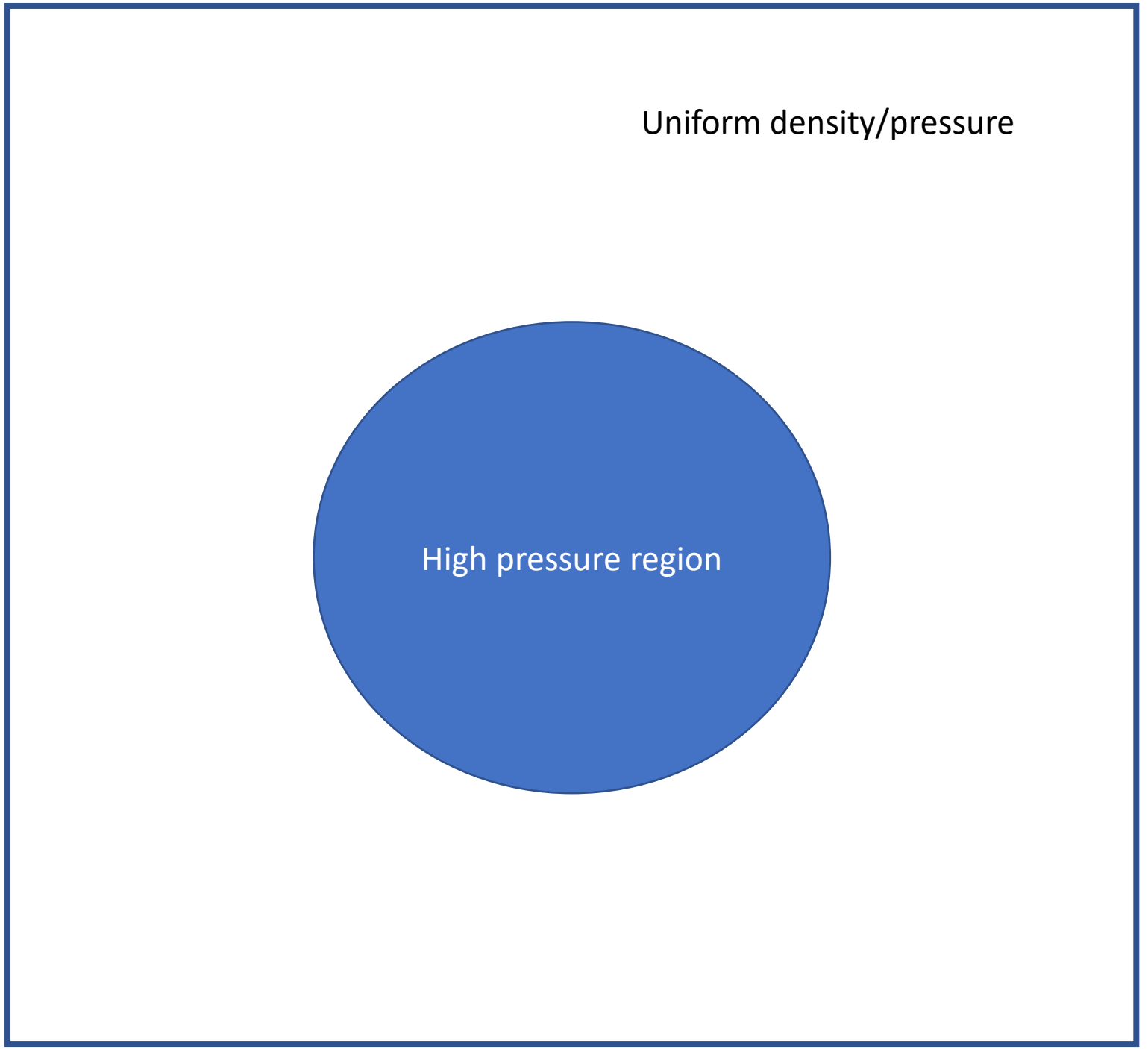
- This demonstration:
  - Using a MacBook Pro laptop
  - Compilers managed/installed with XCODE and MacPorts

Main ingredients of a simulation

- A simulation is just a numerical solution of the set of (non-linear) partial differential equations.
- Need to define...

1. The equations being solved (definitions.h)
   - Physics
   - Coordinate system / definition of grid
2. Boundary conditions (pluto.ini)
3. Initial conditions (init.c)
4. Stopping conditions (pluto.ini)
5. Output information (pluto.ini)

Blast



Wind tunnel