Computational Astrophysics and Cosmology

Open Access Springer Journal

CompAC publishes paper on

- **Astronomy, physics and cosmology**
- **Computational and information science**

The combination of these two disciplines leads to a wide range of topics which, from an astronomical point of view covers all scales and a rich palette of statistics, physics and chemistry. Computing is interpreted in the broadest sense and may include hardware, algorithms, software, networking, data management, visualization, modeling, simulation, visualization, high-performance computing and data intensive computing.

Modeling and Observing Dense Stellar Systems with the Astrophysical Multipurpose Software Environment

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Sterrewacht Leiden

AMUSE

Sterrewacht Leiden


MODEST2 Amsterdam (2003)

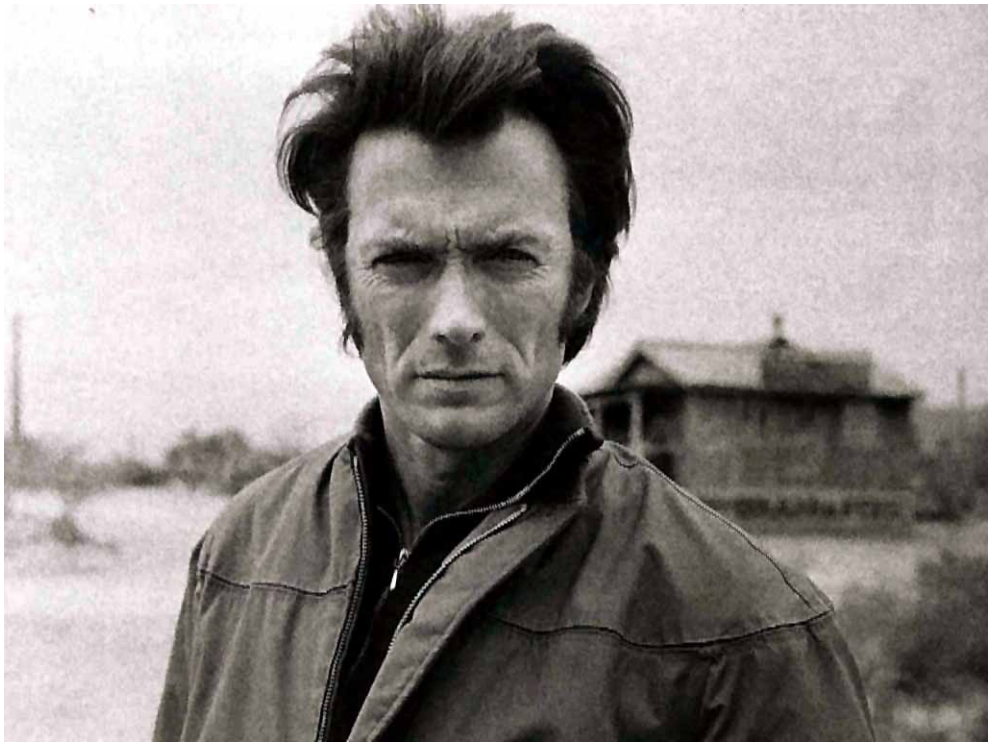
MODEST14 Bad Honnef

AMUSE - philosophy

- Build on community codes
- Standardized interfaces
- Automate as much as possible
- Core Team:
  - Inti Pelupessy (post-doc)
  - Arjen van Elteren (engineer)
  - Nathan de Vries (programmer)
  - David Jansen (user support)

Leiden Dirty Hands Days

- June 18: hydrodynamics AMR, LBM or SPH?
- June 25: Gravity a-la cart, trees, SCF or BS?
- September 17: Radiosity, ray tracing and casting



AMUSE Today

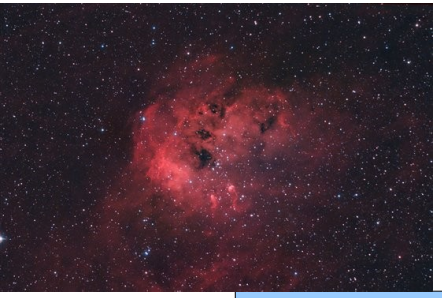
- Automated referencing
- Unit conversion
- Online documentation
- Many of example scripts
- Syllabus and textbook
- Download from: www.amusecode.org

AMUSE's uses

- Astronomical research
  - Multi-scale simulations of astronomical phenomena
  - Multi-physics simulations
- Education at MSc and PhD level
- Public outreach
- Develop a “*gut feeling” of physics*


April 2014

Gravitational dynamics



bridge

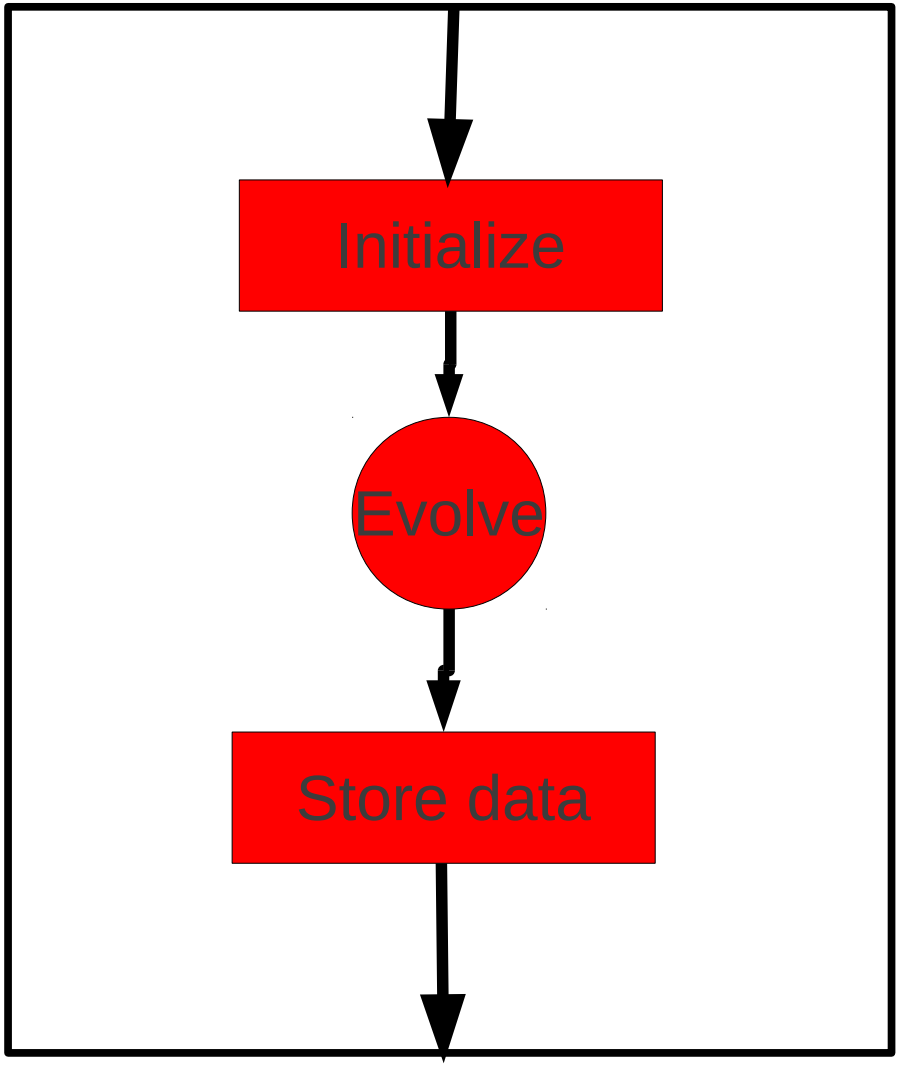
hydrodynamics

AMUSE

Stellar evolution

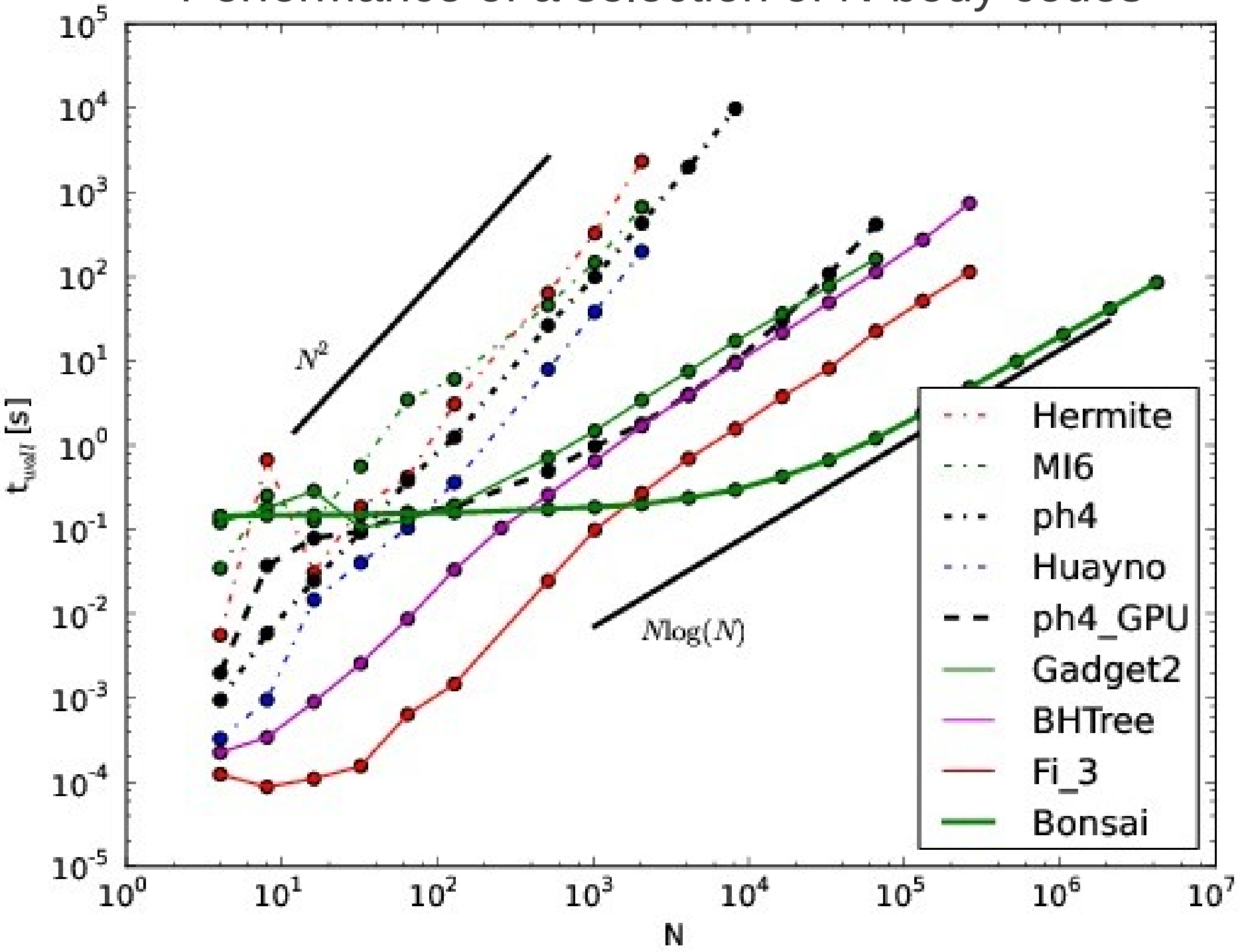
bridge

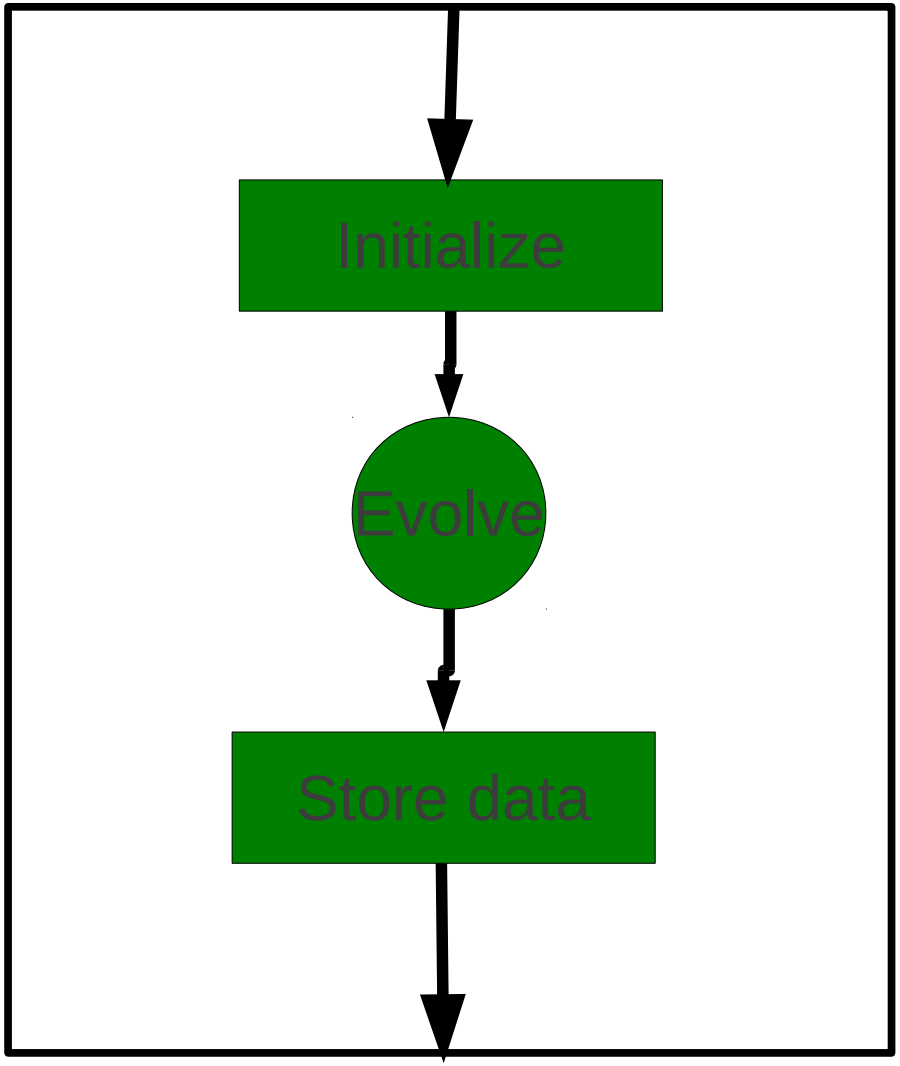
Radiative transport




```
> from amuse.lab import *
> bodies = King_model(N, W0)
> gravity = Hermite()
> gravity.add_particles(bodies)
> gravity.evolve_model(t_end)
>write_to_file(gravity, “grav.hdf5”)
```

Performance of a selection of N-body codes

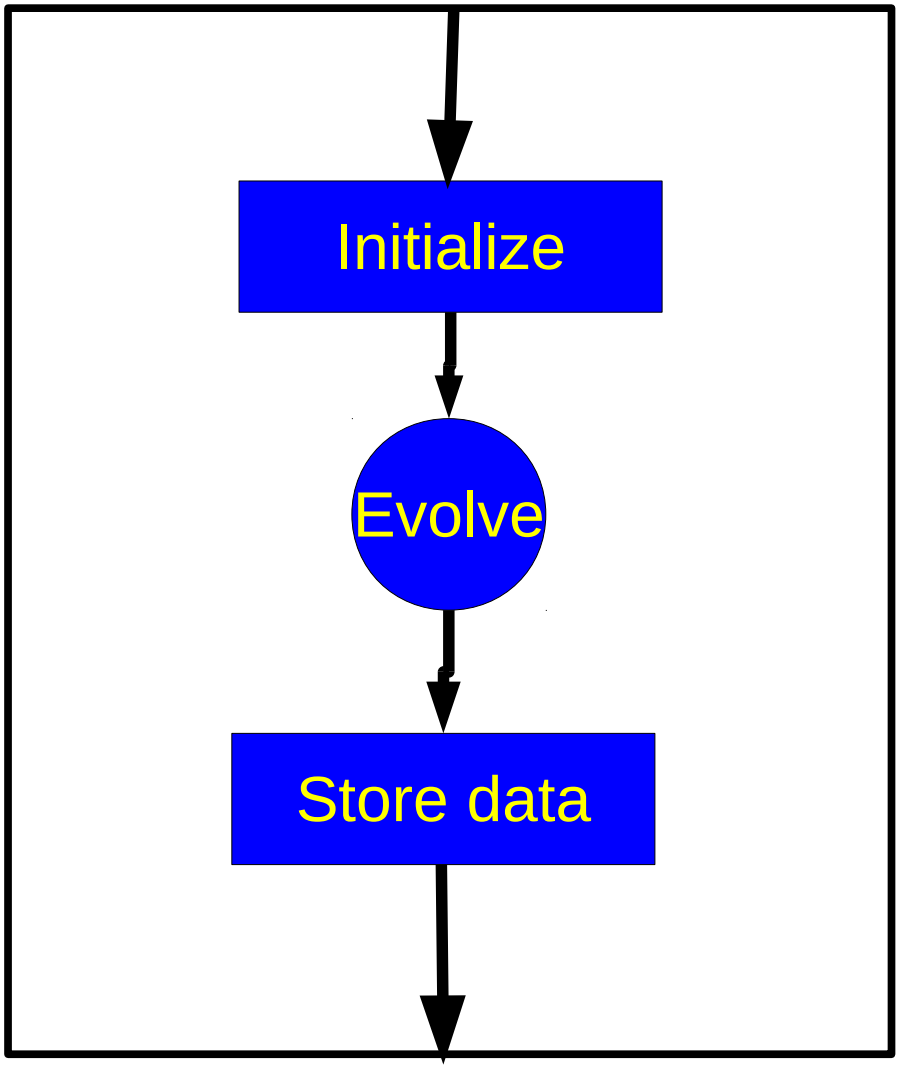




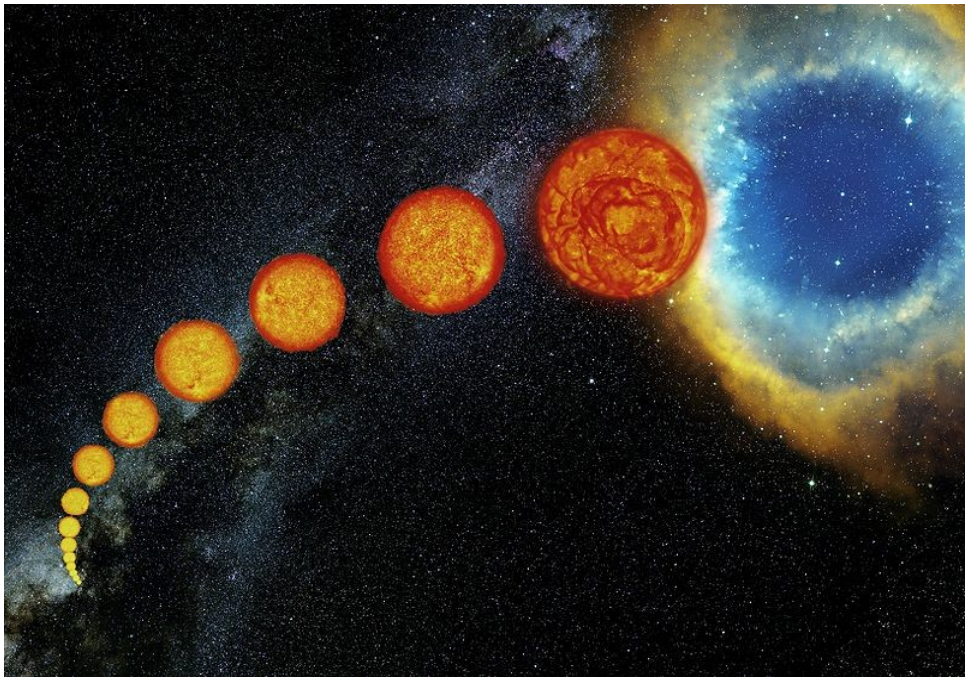

```
> from amuse.lab import *
> bodies = Plummer_gas_model(N)
> hydro = Gadget2()
> hydro.add_particles(bodies)
> hydro.evolve_model(t_end)
> write_to_file(hydro, “hydro.hdf5”)
```

Running in distributed mode:

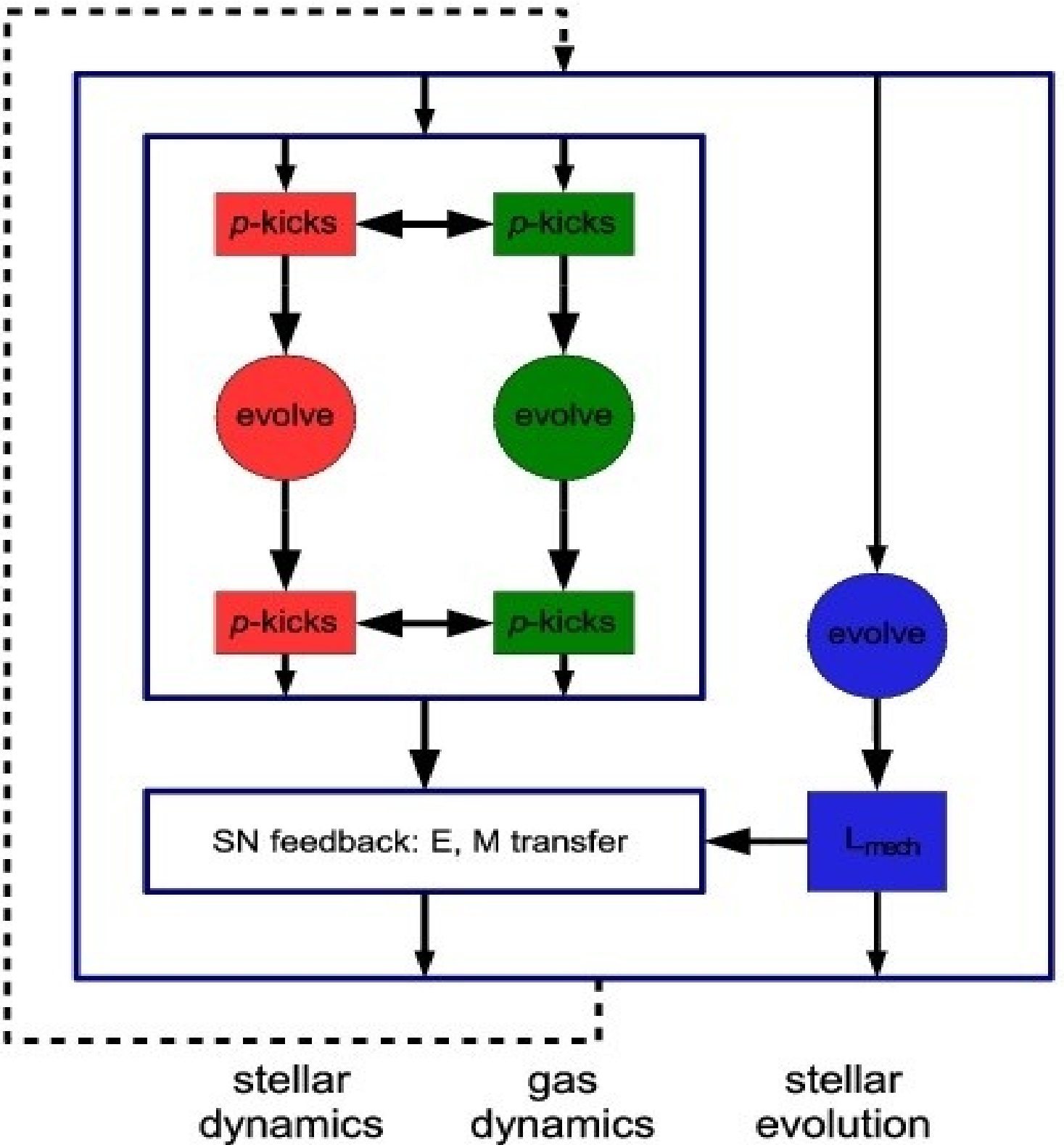
```
> gravity = Gadget2(location=132.229.224.148, nworkers=16)
```



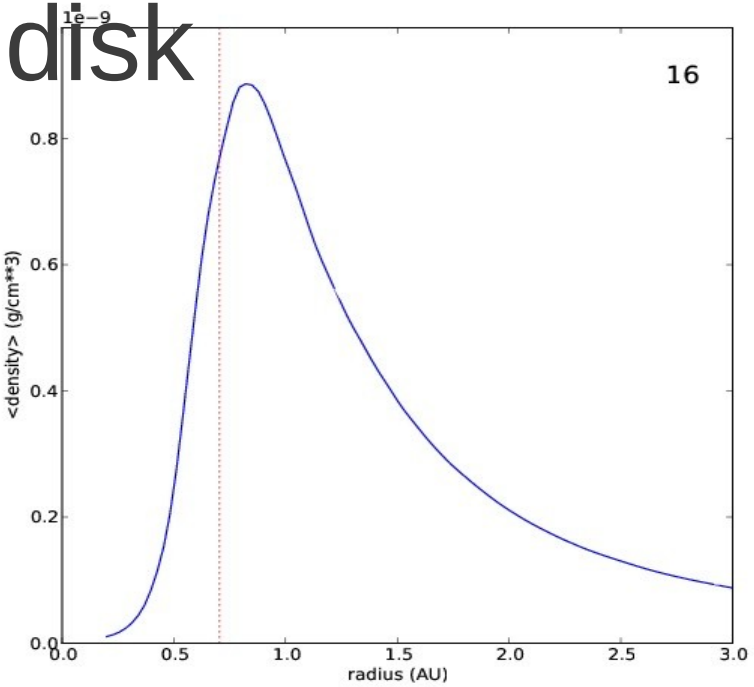

```
> from amuse.lab import *
> bodies = Salpeter(N, Mmin, Mmax)
> stellar = MESA()
> stellar.add_particles(bodies)
> stellar.evolve_model(t_end)
> write_to_file(stellar, “stars.hdf5”)
```

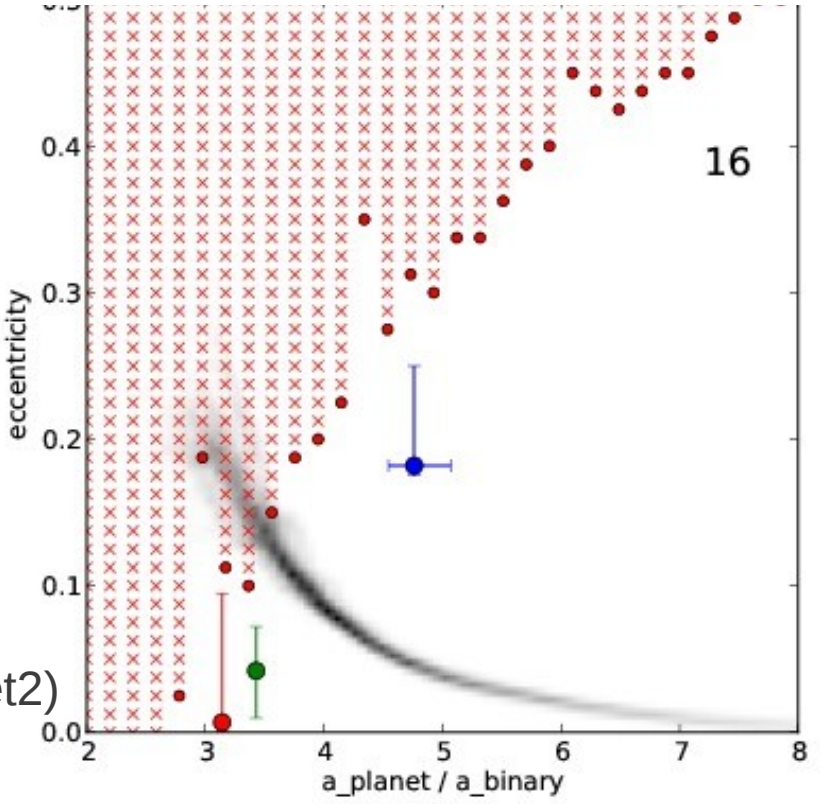


Direct N-body (Hueyno) with stellar evolution (SeBa): by Inti Pelupessy


p-kicks
p-kicks
evolve
evolve
p-kicks
p-kicks
evolve
SN feedback: E, M transfer
L_mech
stellar dynamics
gas dynamics
stellar evolution

Kepler 16 proto-planetary disk





N-body (Var Kepler), stellar ev (MESA) and SPH (Gadget2)

Pelupessy & SPZ MNRAS 2012

Conclusions

- AMUSE is a great tool for studying multi-scale/physics problems in astrophysics
- Applications cover a wide range of topic in astrophysics
- It spawns executable high-performance codes to local or remote machines
- <1% of the wall-clock time is spend in the framework
- But also useful for small experiments, student projects, preliminary studies, outreach...