Practice

Solar System

- extend your Kepler code to model the full solar system even incl. the moon's orbit around the Earth
- study the Lagrange points of the Earth-Sun system
- study of Hohmann transfer orbit

Hydrodynamics

- compare simulations done with GADGET and RAMSES
- extend 1D SPH code to 3D
- run hydrotests with Gadget
- use http://www.skirt.ugent.be/root/index.html for radiative transfer postprocessing

Cosmology (DM only simulations)

- perform and analyse simulations using either
  N-GenIC to generate the initial conditions, and then use
  GADGET and/or AMIGA to run the simulation, and apply
  AHF for the analysis

  Possible science problems to investigate
  - comparing various different cosmologies LCDM, SCDM, OCDM, LWDM, etc.
  - study of cosmic variance
  - investigate resolution/box size effects
  - explore code-to-code variation (i.e. run the same model with 2 different codes)

- access the database www.cosmosim.org and analyse the available halo catalogues

Galaxy Formation

- simulate and analyse the collision of two galaxies (example coming with GADGET, http://www.mpa-garching.mpg.de/gadget)
- access the database www.cosmosim.org and analyse the available galaxy catalogues
- compare various semi-analytical galaxy formation models with each other

Literature

Subgrid Physics

- review of literature about different sub-grid physics like star formation and feedback models (e.g. Piontek & Steinmetz 2011)

GPUs vs CPUs

- literature research on GPU vs CPU computing
- review of recent codes with CUDA implementation
- practical introduction to CUDA programming

Hydrodynamic Schemes

- review of different shock capturing schemes in Eulerian codes, e.g.
  ZEUS (http://www.astro.princeton.edu/~jstone/zeus.html),
  RAMSES (http://www.itp.uzh.ch/~teyssier/Site/RAMSES.html),
  ENZO (http://lca.ucsd.edu/portal/software/enzo),
  FLASH (http://flash.uchicago.edu/website/home)

Supercomputing Frontiers

- review of exascale computing needs (in astrophysics), e.g. https://arxiv.org/abs/1311.2841, http://adsabs.harvard.edu/abs/2012PDU.....1...50K, www.top500.org, + www/literature research

In any case, feel free to also suggest a project that best suits your interests!

Guidelines for the Presentation

a) if your project is relating to 'coding':
- explain the theory
- explain the numerical algorithm
- explain your realisation of that algorithm, but do not(!) source code ... only flowcharts
- show some applications/astrophysics done with your code

b) if your project is related to 'using code'
- explain the steps involved in studying the physical problem of our choice
- explain the algorithm of the code
- show your results
- interpret your results

c) if your project is related to 'literature research'
- provide background information, i.e. an introduction to the field and why this is relevant
- summarize the state-of-the art in the field
- bring your own view/thoughts into the subject

<u>In any case, any presentation should follow these guidelines:</u>

Your end-of-course presentation should be 10 to max. 15 minutes long and cover the following aspects

- general introduction into the field
- objectives of the actual work: what are the aims?
- description of the methodology used to reach those objectives
- results
- discussion of results: why is this interesting?
- possible future follow-up investigations

As a general remark: prepare your presentation in such a way that your fellow students are able to understand it. That means, someone who is not an expert should clearly apprehend the relevance of the results. Therefore, you should give a clear (yet brief) introduction into the field and motivate the results well.

In case you have chosen a literature research project, please note that it is not always important to present and discuss every single plot of the paper. You should focus on the most relevant result(s) and explain those well.