Performing large, intensive or non-trivial computing on array like data structures is one of the most common task in scientific computing, video game development and other fields. This matter of fact is backed up by the large number of tools, languages and libraries to perform such tasks. If we restrict ourselves to C++ based solutions, more than a dozen such libraries exists from BLAS/LAPACK C++ binding to template meta-programming based Blitz++ or Eigen2. If all of these libraries provide good performance or good abstraction, none of them seems to fit the need of so many different user types. Moreover, as parallel system complexity grows, the need to maintain all those components quickly become unwieldy.

This talk explores various software design techniques - like Generative Programming, MetaProgramming and Generic Programming - and their application to the implementation of various parallel computing libraries in such a way that:
- abstraction and expressiveness are maximized
- cost over efficiency is minimized

As a conclusion, we'll skim over various applications and see how they can benefit from such tools.

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**Cosmic Structure Formation on a Moving Mesh**

**Prof. Volker Springel**
Leader of the research group Theoretical Astrophysics at Heidelberg Institute for Theoretical Studies (Germany)

Recent years have seen impressive progress towards hydrodynamic cosmological simulations of galaxy formation that try to account for much of the relevant physics in a realistic fashion. At the same time, numerical uncertainties and scaling limitations in the available simulation codes have been recognized as important challenges. I will review the state of the field in this area, highlighting a number of recent results obtained with large particle-based and mesh based simulations. I will also describe a novel moving-mesh methodology for gas dynamics in which a fully dynamic and adaptive Voronoi tessellation is used to formulate a finite volume discretization of hydrodynamics which offers numerous advantages compared with traditional techniques. The new approach is fully Galilei-invariant and gives much smaller advection errors than ordinary Eulerian codes, while at the same time offering comparable accuracy for treating shocks and an improved treatment of contact discontinuities. The scheme adjusts its spatial resolution to the local clustering of the flow automatically and continuously, and hence retains a principle advantage of SPH for simulations of cosmological structure growth. Applications of the method in large production calculations that aim to produce disc galaxies similar to the Milky Way will be discussed.

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**Tuesday, March 4th 9:30 AM** (coffee offered, talks at 10 AM)
**Maison de la Simulation**, Digiteo building (565), room 33

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