

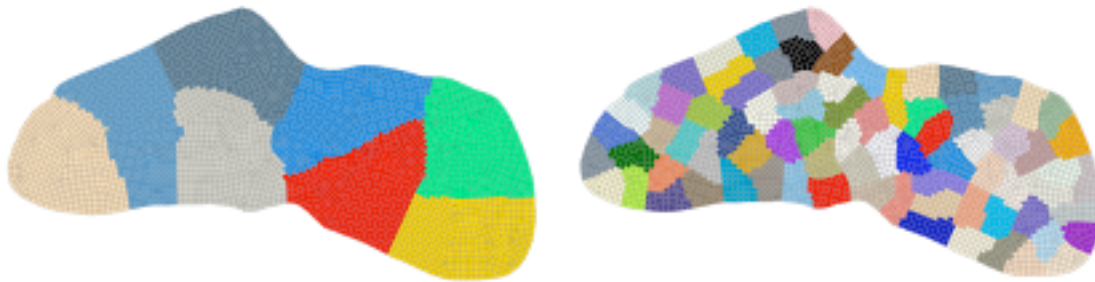
# Simulation of seismic wave propagation in a 3D asteroid model using an unstructured MPI spectral-element method and non-blocking communications

R. Martin, *University of Pau, France*

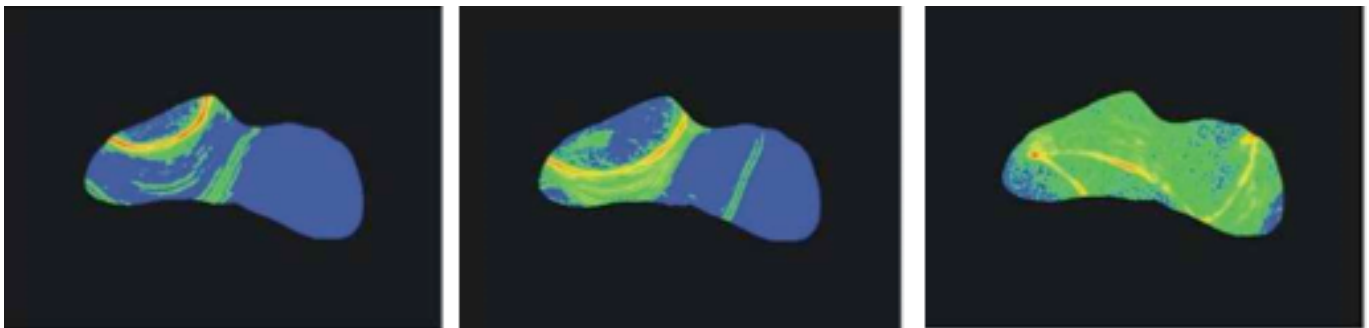
D. Komatitsch, *University of Pau, France; Institut universitaire de France, Paris, France*

J. Labarta, *Barcelona Supercomputing Center, Spain*

We implement spectral-element calculations in parallel in an asteroid based upon MPI. Homogeneous and fractured models are meshed using the CUBIT mesh generator developed at Sandia National Laboratories (USA) and the unstructured meshes are partitioned using the SCOTCH graph partitioning library, which focuses on balancing the size of the different domains and minimizing the edge cut to optimize load balancing in our parallel non-blocking MPI implementations. Balancing the size of the domains ensures that no processor core remains idle for a significant amount of time while others are still running at each iteration of the time loop, while a small edge cut reduces the number and the size of the communications. Contributions between neighboring elements that are located on different processor cores are added using non-blocking MPI sends and receives. Internal force contributions from the outer elements of a given mesh partition are computed first and sent to the neighbors of that mesh slice using a non-blocking MPI send. Similarly, each processor core issues non-blocking MPI receives. Communications are then overlapped by the calculations.



**Figure 1:** *Partitioning of a homogeneous model mesh obtained in the case of 8 (left) and 80 (right) domains. The number of elements along the interface of the partitions is small compared to the number of elements inside each partition in the case of 8 domains and overlapping of communications with calculations works fine. But for 80 domains, this number becomes comparable or even higher than the number of inner elements and overlapping tends to fail with poor performances.*



**Figure 2:** *Snapshots of the propagation of simulated 3D seismic waves in the geological model for a total duration of 20 seconds in the case of a 3D asteroid model with a regolith layer. Snapshots are shown at 4~s, 6~s and 15~s on the 3D surface. We represent the vertical component of the displacement vector.*