Supercomputing means better models of earthquakes, cells and the universe

Courtesy of the National Center for Supercomputing Applications, University of Illinois at Champaign-Urbana

A model of the Illinois Petascale Computing Facility at the University of Illinois at Urbana-Champaign. This building will house the next-generation of even faster-thinking supercomputer called Blue Waters.

***by* Jeffery Barker**
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State of the art supercomputers can build a better cell – or at least a better model of a cell.

They can build more precise atoms and even capture hidden horizons of the universe such as dark matter.

A diverse group of researchers modeling everything from nanostructures to earthquakes gathered over the weekend in Chicago at a symposium of the American Association for the Advancement of Sciences. The profiled the supercomputers that make their work possible.

More and more scientists are making use of smarter, faster computing power to spend less time working out models. That kind of brain power can fill up as much as 150,000 processors.

Faster supercomputers allow researchers to “get out of the mode of hero experiments” that drag on for days, said Gerhard Kilmeck, an electrical engineer at Purdue University.

In addition to faster modeling, cutting edge supercomputers give models sharper resolution and higher accuracy.

Jeroen Tromp of the California Institute of Technology models the source and outward spread of earthquakes. His team does on-demand modeling of earthquakes in Southern California right after they happen. More accurate models could mean a better understanding to locate vulnerable areas.

They track how fast waves of energy travel out from a quake’s epicenter over the land and through the Earth’s crust. When waves travel more slowly over certain areas such as the Los Angeles basin the force of them essentially piles up and more impact is felt.

There were discrepancies between his team’s old model and the seismographic data that comes in from earthquake monitoring stations. The new model fits the observed quake readings much more closely.

“We can do this because of fully three-dimensional computer models,” said Tromp.

Klaus Schulten studies the physics of cells at the University of Illinois at Urbana-Champaign. Supercomputing allows him to see how a protein stretches out into the static forms we usually see. Powerful computer modeling means the normally unobservable metamorphosis of a protein unwinding can be better understood.

“To describe the cell at its natural beat, like music, you must describe it in microseconds,” said Schulten.

Yet the information gained from modeling has to be compared with experimental data. When Schulten first published a study based on a simulation, it was ignored until data from electromagnetic images of cells confirmed his findings.

Supercomputing allows Tiziana Di Matteo, an astrophysicist at Carnegie Mellon University, to study another mystery of the undetectable. Dark matter makes up the majority of matter in the universe, but “the only way to see it is by simulating it,” said Di Matteo. Dark matter is matter that doesn’t reflect light. It has defied studies to determine how it impacts the universe and galactic processes.

Di Matteo separates the universe into cubes and models each cube. Simulations have helped her team see how two galaxies collide to form one.

“The science of cosmology is driven by computations,” said Di Matteo.

The National Center for Supercomputing Applications at the University of Illinois is building a new supercomputer that’s many times more powerful than current systems. The new computer, called Blue Waters, is designed to run “a quadrillion calculations every second,” according to the NCSA. Blue Waters is scheduled to come online in 2011.