Usage Report for Fiscal Year 2020

Project Title:

Supernova remnants: from the explosion to the interstellar medium

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1. Background and purpose of the project, relationship of the project with other projects

This project is about supernova remnants (SNRs), which are the final stage of evolution of some stars, and as such are key in the cycle of matter in the Galaxy. The aim is to reveal the mechanisms that shape SNRs, from their generation in a supernova explosion to their dilution in the interstellar medium. I want to elucidate how different explosion engines produce different SNRs, and how SNRs interact with their environment - and how these effects play together to reach a complete understanding. Because of the complex multi-scale physics involved, this study requires the use of state-of-the-art numerical simulations. In particular they have to be 3-dimensional to properly reproduce the SNR geometry.

This project is complementary with the other research in my laboratory, on SNRs and more generally on explosive phenomena.

2. Specific usage status of the system and calculation method

The main point of the project is to use realistic supernova models (obtained from colleagues in Germany) as inputs for the SNR simulations.

To do this, I have mainly been using the computer clusters of the iTHEMS program. On Hokusai I have only done a few simulations, to cross-check the results and to test the system.

3. Result

We have sucessfully shown how the SN can imprint the SNR, and that different SN models produce different remnants.

4. Conclusion

5. Schedule and prospect for the future

The project has good perspectives, and the next steps shall make more use of Hokusai:

- The simulations so far were hydrodynamics only. Next we will compute the ionization state and thermal emission of the supernova ejecta, to compare with X-ray observations. Because of the need to follow the individual species, this will require more memory. The BigWaterfall computer will be good for this thanks to its larger memory per core.
- The simulations have been done at moderate spatial resolution 256^3. Once we know what are the good models, we can re-run some at higher spatial resolution. Here again we will need the large number of CPUs of Hokusai.