THE UNIVERSITY OF TOKYO

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JCAHPC

Software development for numerical astrophysics and its application

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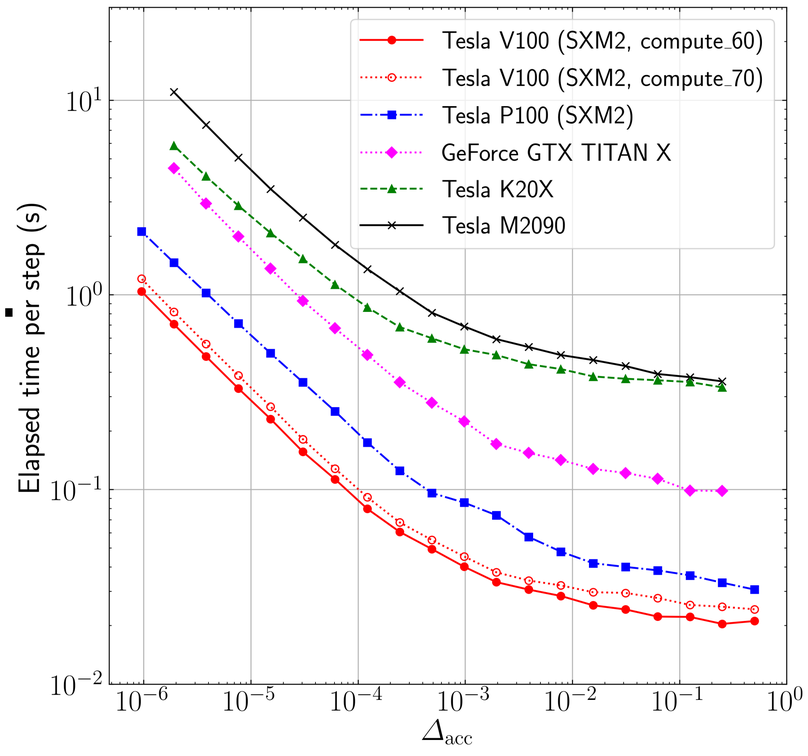
Development of gravitational octree code for GPU

- GOTHIC: Gravitational Oct-Tree code accelerated by HIerarchical time step Controlling (Miki & Umemura 2017)
- The code includes both the tree method and the hierarchical time step.
- The code is written in CUDA C/C++ and runs entirely on GPU.
- Tesla V100 achieves 2.2-fold acceleration in comparison with Tesla P100 by hiding the execution time of the integer operations (Miki 2019).
- Specifying -gencode arch=compute_60,code=sm_70 enables a 1.1 to 1.2-fold acceleration.

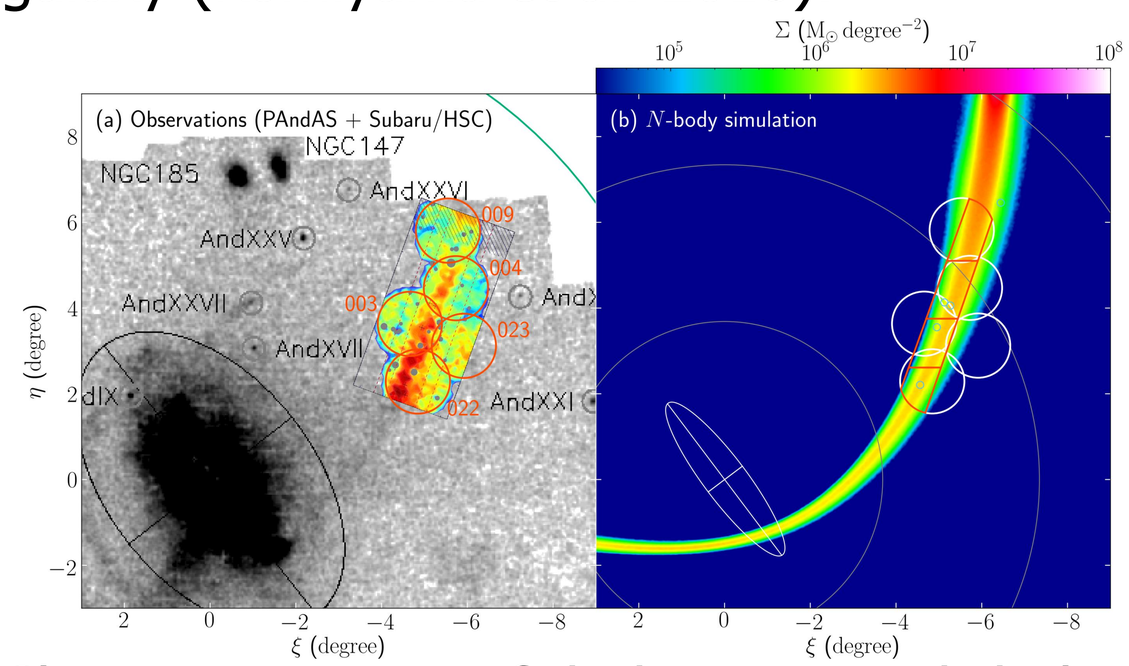


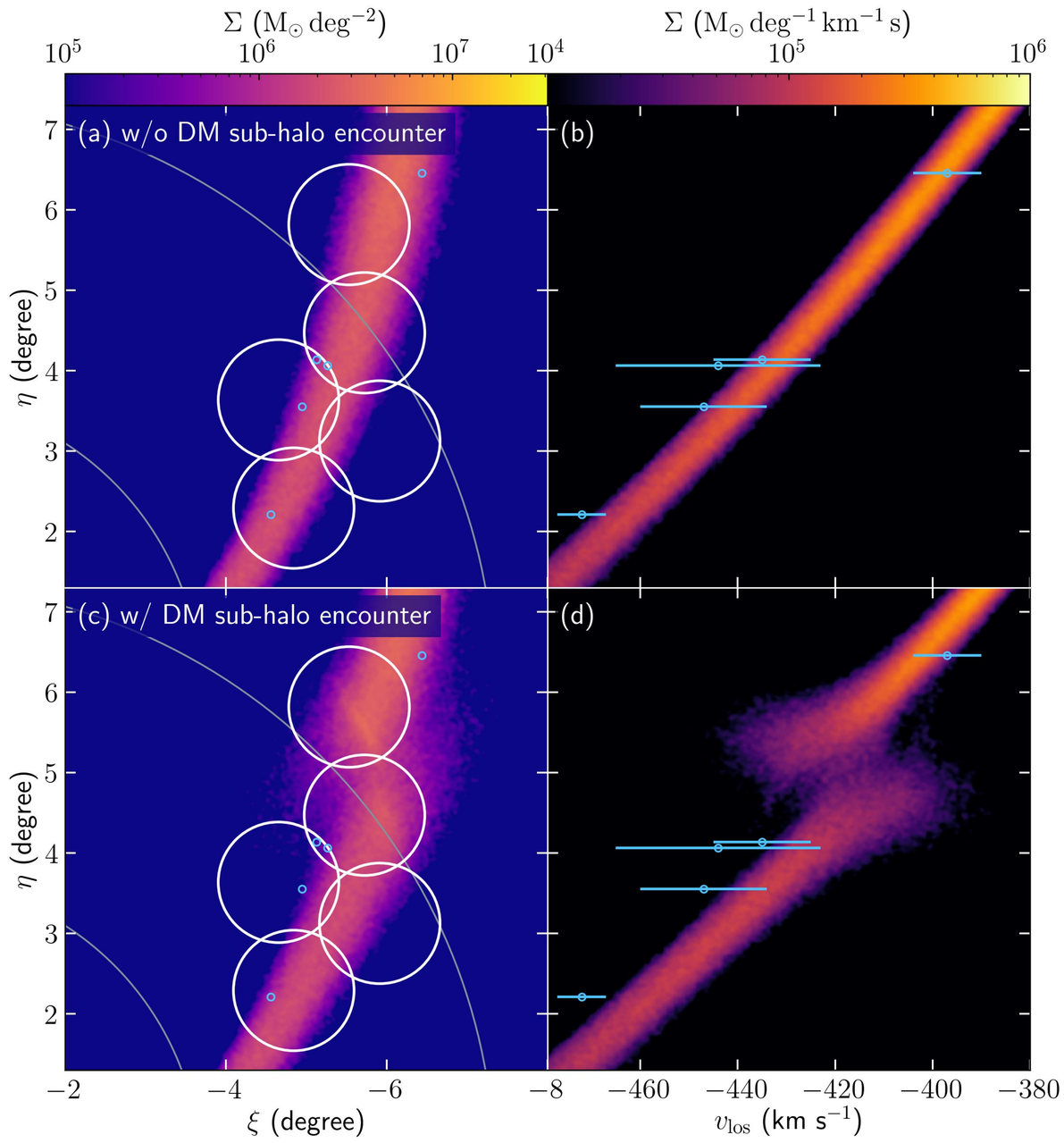
Development of initial-condition generator

- MAGI: MAny-component Galaxy Initializer (Miki & Umemura 2018)
- The code supports various types of density models, their superposition, and the presence of multiple disks.
- Model galaxies representing elliptical and disk galaxies maintain their initial distributions for over a billion years.
- Publicly and freely available at https://bitbucket.org/ymiki/magi.

Galactic archeology: synergetic study of HPC and observations

- Stellar halos of galaxies provide fossil records of the formation and the evolution of galaxies.
- N-body simulations using MAGI and GOTHIC have reproduced the observed structure of the North-Western stream in the Andromeda galaxy (Komiyama et al. 2018).





- Close encounters of dark matter sub-halos create distinct signatures in the stellar stream.
- The synergy of the state-of-the-art numerical simulations, Subaru/HSC, and Subaru/PFS will elucidate the nature and assembly history of the dark matter halo.

Reference:
Miki & Umemura (2017), “GOTHIC: Gravitational oct-tree code accelerated by hierarchical time step controlling”, New Astronomy, 52, 65
Miki & Umemura (2018), “MAGI: many-component galaxy initializer”, Monthly Notices of the Royal Astronomical Society, 475, 2269
Komiyama et al. (2018), “Stellar Stream and Halo Structure in the Andromeda Galaxy from a Subaru/Hyper Suprime-Cam Survey”, The Astrophysical Journal, 853, 29
Miki (2019), “Gravitational Octree Code Performance Evaluation on Volta GPU”, In 48th International Conference on Parallel Processing (ICPP 2019)