Summary of East-Asia Numerical Astrophysics Meeting 2012 (EANAM 2012) during October 29 to November 2, 2012 in Yukawa Institute of Theoretical Physics (YITP)

Dongsu Ryu
Chungnam National University, Korea

EANAM (East-Asia Numerical Astrophysics Meeting)

- 0th Meeting - 2002 in ASIAA, Taipei, Taiwan
  (EANAM was suggested)
- 1st Meeting - 2004 in NAOJ, Mitaka, Japan
- 2nd Meeting - 2006 in KASI, Daejeon, Korea
- 3rd Meeting - 2008 in PMO, Nanjing, China
- 4th Meeting - 2010 in ASIAA, Taipei, Taiwan
- 5th Meeting - 2012 in YITP, Kyoto, Japan
- 6th Meeting - 2014 in Kyunghee Univ., Korea
  (Suwon, suburb of Seoul, Tentative)

Progresses over the last 10 years in numerical astrophysics (partial list)

- codes with second-order schemes → higher-order schemes
- single-level grid → nested grid, AMR
- ~ 100^3 zones or particles → ~ 1000^3 zones or particles
- adiabatic simulations → simulations with multi-physics
- cooling/heating → radiative transfer
- images → movies
- and etc

Partial list of topics covered in this EANAM

- N-body/SPH simulations
  halo formation, galaxy formation
  formation of our Galaxy
  planet formation
  dust coalition

- Hyrdodynamic and MHD simulations
  first star formation, star formation
  protostellar, accretion and galactic disks
  jet, supernova explosion
  clusters of galaxies
  turbulence and dynamo
  reconnection

Relativistic hydrodynamic and MHD simulations and Gravitational radiation

GRBs

merger of neutron stars and black holes

jet and accretion disk around black holes

Radiation hydrodynamic and MHD simulations

star formation

jet and accretion disk around back holes

SPH simulations

galaxy formation, accretion disk

Particle acceleration

fluid simulation, PIC simulation

Code developments

N-body/SPH, radiative transfer

gyrokinetic code

Future direction for numerical astrophysics (personal view)

- Development toward better working codes
  ← higher-order, more accurate schemes
  but at the same time, more robust schemes
- Toward higher resolution ← instabilities, turbulence, SF, and etc
  clusters with larger N_{cores} → more efficient parallelization
  nested grid, AMR → higher-order, more accurate scheme
- Introduction of new codes, for example
  for N-body, Vlasov-Poisson code, and etc
  for plasma
  PIC (particle-in-cell) code
  gyro-kinetic code
  gyro-fluid code
  fluid (hydro, MHD) code

smaller scales
← gyro scale
← collision scale
larger scales

- Radiation hydrodynamics and MHD, radiative transfer

- More physics in simulations:
  some are incorporated as phenomenology models based on incomplete understanding of them
  e.g.) star formation and feedback in galaxy formation
  → results in large uncertainties
  need more works to understand them from first principles

- Further physics issues:
  e.g.) turbulence and magnetic fields in astrophysical processes
  reconnection of magnetic fields
  small-scale instabilities and microscopic physics
  dissipation at small scales
  equation of state in dense nuclear matter
  and etc
  need better understanding of them

- More efforts to visualize the data

Numerical Astrophysics in East-Asia

- World leading computing facilities such as
  - K-computer in Japan (2nd in Top 500 supercomputers)
  - Tianhe-1A in China (5th in Top 500 supercomputers)
  - Tachyon II in Korea (64th in Top 500 supercomputers)
  - Alps in Taiwan (98th in Top 500 supercomputers)

  - how to utilize them for astrophysics?
- Numerical astrophysics
  - still minor among astronomy and astrophysics !
- After 10 years efforts with EANAN
  - the regional collaboration not much enhanced ?
- Focused on a number of topics
  - strength or weakness?

Future Direction

- ???

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