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Two major radiative transfer (RT) techniques have been developted to model late-type galaxies: approximate RT and Monte Carlo (MC) RT. In the approximate RT, first proposed by Kylafis & Bahcall, only two terms of unscattered (direct) and single-scattered intensities are computed and higher-order multiple scattering components are approximated, saving computing time and cost compared to MC RT. However, the approximate RT can yield errors in regions where multiple scattering effect is significant. In order to examine how significant the errors of the approximate RT are, we compare results of the approximate RT with those of SKIRT, a state-of-the-art MC RT code, which is basically free from the approximation errors by fully incorporating all the multiple scattered intensities. In this study, we present quantitative errors in the approximate RT for late type galaxy models with various optical depths and inclination angles. We report that the approximate RT is not reliable if the central face-on optical depth is intermediate or high ($\tau_V >$ 3).

[구 IM-03] An Implementation of the Adaptive Ray Tracing Method in the Athena Code

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The incorporation of radiation from massive stars is essential for modeling the dynamics and chemistry of star-forming clouds, yet it is a computationally demanding task for three-dimensional problems. We describe the implementation and tests of radiative transfer module due to point sources on a three-dimensional Cartesian grid in the Eulerian MHD code Athena. To solve the integral form of the radiation transfer equation, we adopt a widely-used long characteristics method with spatially adaptive ray tracing in which rays are split when sampling of cells becomes coarse. We use a completely asynchronous communication pattern between processors to accelerate transport of rays through a computational domain, a major source of performance bottleneck. The results of strong and weak scaling tests show that our code performs well with a large number of processors.

We apply our radiation hydrodynamics code to some test problems involving dynamical expansion of HII regions.

[구 IM-04] Estimation of Fuel Rate on the Galactic Disk from High Velocity Cloud (HVC) Infall

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Continuous accretion of metal-poor gas can explain the discrepancy between the number of observed G-dwarfs and the number predicted by the "simple model" of galactic evolution. The maximum accretion rate estimated based upon approaching high velocity clouds (HVCs) can be up to ~0.4 $M_\odot \cdot yr^{-1}$ which is comparable with the accretion rate required by many chemical evolution models that is at least ~0.45 $M_\odot \cdot yr^{-1}$. However, it is not clear to what extent the exchange of gas between the disk and the cloud can occur when an HVC collides with the galactic disk. Therefore, we examined a series of HVC-Disk collision simulations using the FLASH 2.5 hydrodynamics simulation code. The outcomes of our simulations show that an HVC will more likely take away substances from the galactic disk rather than adding new material to the disk. We define this as an HVC having a "negative fuel rate". Further results in our study also indicate that the process and amount of fuel rate change can have various forms depending on the density, radius and velocity of an approaching HVC. The simulations in our study covers HVCs with a neutral hydrogen volume density from 1.0×10^{-2} cm^{-3} to 41.0 cm^{-3}, radius of 200 pc to 1000 pc and velocity in the range between 40 $km \cdot s^{-1}$ and 100 $km \cdot s^{-1}$.

[구 IM-05] Formation of star cluster clumps in the strong tidal field with initial fractal distribution

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산개 성단이 형성 되는 시기에 성단 내 별들이 가지는 공간 분포는 구대칭에서 상당히 멀 것으로 추정되며, 프랙

털(fractal) 구조에 가까울 것으로 생각된다. 본 연구에서는 프랙털 구조를 가지고 태어나는 성단이 조석력장에 놓여 있을 때 어떤 진화를 겪는지 N-body 시뮬레이션을 통해 살펴보았다. 조석력장이 없을 때와 달리, 강한 조석력장이 적용되었을 때에는 성단 내 별들이 더 작은 무리(clump)를 이루면서 진화하는 것이 관측되었다. 이러한 결과는 Arches 성단처럼 은하의 조석력장이 강한 우리은하 중심부에서 발견되는 성단들의 형성에 제약조건을 줄 수 있을 것으로 예상된다.

[구 IM-06] Several factors affect density and magnetic field correlation

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Turbulent motions produce density and magnetic field fluctuations. Correlation between density and magnetic field fluctuations are important for interpretation of observations, such as the rotation measure (RM) and dispersion measure (DM).
We study the several factors that can affect the correlation between two. In particular, we numerically investigate how the correlation time of driving affects the correlation between density and magnetic field. We perform compressible MHD turbulence simulations at different sonic Mach number and consider two different driving schemes – continuously changing driving and delta-correlated driving. The continuously changing driving results in strong anti-correlation between density and magnetic field when sonic and Alfvenic Mach numbers are similar unity. The delta-correlated driving produces virtually no correlation between two fields.

고천문학 및 교육홍보

[구 HA-01] Calculation method for the solar and lunar motions in the Chongxiu Daming calendar

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이 연구에서는 중수대명력(重修大明曆)에서 태양과 달의 운동 계산 방법에 대해 분석하였다. 중수대명력은 금(金)대의 양급(楊級)이 만든 대명력을 당대의 조지미(趙知微)가 중수한 역법으로 1281년 수시력(授時曆)이 도입되기 전까지 원(元)에서 사용되었다. 반면 조선에서는『칠정산내편』,『칠정산외편』과 더불어 일·월식 계산에 사용된 것으로 알려져 있다. 이를 위해 세종 26년(1444)에는 이순지(李純之) 등에 의해『중수대명력』과『중수대명력 정묘년 교식가령(丁卯年 交食假令)』등이 편찬되었으며,『중수대명력』의 경우『금사(金史)』의 내용과 동일한 것으로 알려져 있다. 이 논문에서는 이들 문헌을 활용하여 중수대명력에서의 태양과 달의 운동, 특히 이들의 부등속운동 계산 방법에 대해 분석하고, 이를 수시력에서의 방법과 비교 하였다.

[구 HA-02] A Study on the Internal Composition for the Operating Mechanism of Heumgyeonggaknu(欽敬閣漏) -On the Internal Composition of Clepsydra and Jujeon(籌箭)-

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흠경각루(欽敬閣漏)는 1438년 장영실(蔣英實)이 제작한 수격식 천문시계이다. 흠경각루의 작동메커니즘은 물시계, 수차, 수차제어시스템, 기륜, 주전, 각종 기어 등이 유기적으로 작동하여 가산 위의 태양운행장치와 37명의 시보인형들을 움직이게 하는 것이다. 이 연구는 흠경각루의 작동메커니즘에 따른 가산 내부의 공간구성에 관한 것이다. 특히, 흠경각루의 동력발생 장치 부분인 물시계와 수차의 위치, 시보대 위의 신호발생장치인 주전(籌箭)에 대하여 연구하였다. 주전은 시보인형들이 종, 북, 징을 타격하여 12시와 경점시간을 알리게 하는 신호를 주는 것이다. 이를 위해 흠경각루의 기륜을 움직이기 위해 필요한 물시계와 수차의 크기를 결정하였다. 또한 주전의 작동메커니즘에 대해 분석하고, 구체적인 주전의 형태를 3D 모델링으로 구현하였다.

[구 HA-03] A Preliminary Study on the Model of the Shadow Definer (影符) Using for the Large and Small Gnomon of Joseon

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이 논문에서는『원사』「천문지」<경부>조의 기록을 바탕으로 조선시대 영부에 대해 연구하였다. 조선에서는 1435년과 1440년에 처음으로 대규표와 소규표가 제작되었으며, 이들은 모두 횡량을 가진 진화된 형태의 규표로써