exploring the SN Ia light-curve hyperparameter space by Markov Chain Monte Carlo (MCMC) sampling. We test to see how the posteriors of these hyperparameters depend on cosmology, whether using different dark energy models or reconstructions shift these posteriors. Our constraints on the SN Ia light-curve hyperparameters from our model-independent analysis are very consistent with the constraints from using different parameterizations of the equation of state of dark energy, namely the flat Λ CDM cosmology, the Chevallier-Polarski-Linder model, and the Phenomenologically Emergent Dark Energy (PEDE) model. This implies that the distance moduli constructed from the JLA data are mostly independent of the cosmological models. We also studied that the possibility the light-curve parameters evolve with redshift and our results show consistency with no evolution. The reconstructed expansion history of the universe and dark energy properties also seem to be in good agreement with the expectations of the standard ΛCDM model. However, our results also indicate that the data still allow for considerable flexibility in the expansion history of the universe. This work is published in ApJ.

[구 CD-08] Model Independent Statistics in Cosmology

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In this talk, I will discuss a few different techniques to reconstruct different cosmological functions, such as the primordial power spectrum and the expansion history. These model independent techniques are useful because they can discover surprising results in a way that nested modeling cannot. For instance, we can use the modified Richardson Lucy algorithm to reconstruct a novel primordial power spectra from the Planck data that can resolve the "Hubble tension". This novel primordial power spectrum has regular oscillatory features that would be difficult to find using parametric methods. Further, we can use Gaussian process regression to reconstruct the expansion history of the Universe from low-redshift distance datasets. We can also this technique to test if these datasets are consistent with one another, which essentially allows for this technique to serve as a systematics finder.

[석 CD-09] CMASS galaxy sample and the ontological status of cosmological principle

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SDSS-III BOSS DR12 은하적색이동 탐사 자료 중 CMASS 표본을 사용하여 물질 분포에 대한 균일성 테스트를 수행하였다. 균일성의 비교 기준으로는 (i) 완전한 무작위 분포, (ii) Horizon Run 3 N-체 수치실험에서 얻은 헤일로 목록, 그리고 (iii) 물질 요동의 파워 스펙트럼과 로그정규분포를 가정해 얻은 모의 은하 목록을 사용하였다. 현재 관측된 영역에서 통계적으로 의미가 있는 가장 큰 규모인 $300h^{-1}$Mpc까지 조사한 결과, 우리는 관측된 물질 분포가 무작위 분포와 비교하여 전혀 균일하지 않지만 우주론으로부터 구한 나머지 두 목록과는 부합함을 보였다. 우주의 균일 등방성을 제시하는 우주론 원리는 우주론의 이론적 전개에서 물질의 분포가 아닌 공간곡률에 적용된다. 지금 우주모형에서는 이 원리에서 벗어난 공간곡률의 정도가 충분히 작으므로 우주론 원리를 우주론에 적용하는 데 문제가 없다. 하지만 우리는 물질 분포가 균일 등방성에서 벗어난 정도가 상당함을 보였으며, 따라서 우주론 원리가 이론적 모형에 성공적으로 적용되지만 실제로 관측된 은하 분포에는 존재하지 않는다는 기존의 결론을 새로운 자료를 이용해 강화하였다.

특별세션-기계학습

[구 ML-01] Deep Learning the Large Scale Galaxy Distribution

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I will give an overview of the recent work in deriving cosmological constraints from deep learning methods applied to the large scale distribution of galaxies. I will specifically highlight the success of convolutional neural networks in linking the morphology of the large scale matter distribution to dark energy parameters and modified gravity scenarios.

[구 ML-02] Weak-lensing Mass Reconstruction of Galaxy Clusters with Convolutional Neural Network

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We introduce a novel method for reconstructing the projected matter distributions of galaxy clusters with weak-lensing (WL) data based on convolutional neural network (CNN). We control the noise level of the galaxy shear catalog such that it mimics the typical properties of the existing Subaru/Suprime-Cam WL observations of galaxy clusters. We find that our mass reconstruction based on multi-layered CNN with architectures of alternating convolution and trans-convolution filters significantly outperforms the traditional mass reconstruction methods.

[구 ML-03] Reconstructing the cosmic density field based on the generative adversarial network.

Feng Shi
Korea Astronomy and Space Science Institute

In this topic, I will introduce a recent work on reconstructing the cosmic density field based on the GAN. I will show the performance of the GAN compared to the traditional Unet architecture. I'd also like to discuss a 3-channels-based 2D datasets for the training to recover the 3D density field. Finally, I will present some performance tests based on the test datasets.

[구 ML-04] From dark matter to baryons in a simulated universe via machine learning

Yongseok Jo
Seoul National University

The dark matter (DM) only simulations have been exploited to study e.g. the large scale structures and properties of a halo. In a baryon side, the high-resolution hydrodynamic simulation such as IllustrisTNG has helped extend the physics of gas along with stars and DM. However, the expansive computational cost of hydrodynamic simulations limits the size of a simulated universe whereas DM-only simulations can generate the universe of the cosmological horizon size approximately.
I will introduce a pipeline to estimate baryonic properties of a galaxy inside a dark matter (DM) halo in DM-only simulations using a machine trained on high-resolution hydrodynamic simulations. An extremely randomized tree (ERT) algorithm is used together with multiple novel improvements such as a refined error function in machine training and two-stage learning. By applying our machine to the DM-only simulation of a large volume, I then validate the pipeline that rapidly generates a galaxy catalog from a DM halo catalog using the correlations the machine found in hydrodynamic simulations. I will discuss the benefits that machine-based approaches like this entail, as well as suggestions to raise the scientific potential of such approaches.

항 성 및 항 성 계

[구 SA-01] Sejong Open cluster Survey (SOS). VII. A Photometric Study of the Young Open Cluster IC 1590

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We present deep $UBVI_c$ and $H\alpha$ photometry for the young open cluster IC 1590 which is at the center of the HII region NGC 281. From $H\alpha$ index, 39 $H\alpha$ emission stars and 15 $H\alpha$ emission candidates are selected. The reddening law toward IC 1590 is slightly abnormal ($R_{V,cl}$ = 3.6 ± 0.2). The distance modulus of IC 1590 obtained from the reddening-free (Q', $Q_{V\lambda}$) diagrams is 12.4 ± 0.1 mag (d = 3.02 ± 0.14 kpc), which is consistent with distance d = 2.91 ± 0.42 kpc from the parallax of Gaia DR2 catalogue within the error range. We also determined the age and mass function of IC 1590 using the stellar evolution models and PMS evolutionary tracks. The median age of PMS stars is 2.4 ± 2.2 Myr. The initial mass function (IMF) of IC 1590 is the Salpeter-type IMF with a slope of Γ = -1.26 ± 0.14 for m > 1 $M_\odot$ stars.

[구 SA-02] Discovery of Raman-scattered He II Features at 6545 Å in Planetary Nebulae NGC 6886 & NGC 6881 from BOES Spectroscopy

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We report our discovery of Raman-scattered He II λ6545 feature in young planetary nebulae NGC