surveys

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In the local Universe, the gravitational effects of mass density fluctuations exert perturbations on galaxies' redshifts on top of Hubble's Law, called 'peculiar velocities'. These peculiar velocities provide an excellent way to test the cosmological model in the nearby Universe. In this talk, we present new cosmological constraints using peculiar velocities measured with the 2MASS Tully-Fisher survey (2MTF), 6dFGS peculiar-velocity survey (6dFGSv), the Cosmicflows-3 and Cosmicflows-4TF compilation. Firstly, the dipole and the quadrupole of the peculiar velocity field, commonly named 'bulk flow' and 'shear' respectively, enable us to test whether our cosmological model accurately describes the motion of galaxies in the nearby Universe. We develop and use a new estimators that accurately preserves the error distribution of the measurements to measure these moments. In all cases, our results are consistent with the predictions of the Λ cold dark matter model. Additionally, measurements of the growth rate of structure, fσ8 in the low-redshift Universe allow us to test different gravitational models. We developed a new estimator of the "momentum" (density weighted peculiar velocity) power spectrum and use joint measurements of the galaxy density and momentum power spectra to place new constraints on the growth rate of structure from the combined 2MTF and 6dFGSv data. We recover a constraint of fσ8=0.404+0.082-0.081 at an effective redshift zeff=0.03. This measurement is also fully consistent with the expectations of General Relativity and the Λ Cold Dark Matter cosmological model.

[구 GC-17] High-resolution CMB bispectrum estimator for future surveys

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The Cosmic Microwave Background (CMB) contains a wealth of information about the perturbations in the early universe. Its bispectrum, the Fourier counterpart of three-point correlation functions, is a direct probe of primordial non-Gaussianity predicted by many physically well motivated inflation models. Motivated by the substantial improvement in sensitivity expected from future CMB surveys, we developed a novel bispectrum estimator capable of handling such high-resolution data. Our code, named CMB-BEst, utilises a set of separable basis functions to constrain a wide variety of models simultaneously. Flexibility in the choice of basis enables targeted analysis on highly oscillatory inflation models, which are previously unconstrained due to the numerical and computational challenges involved. We present the results of our thorough validation tests, both internal and against conventional approaches. We provide a proof-of-concept example with Planck satellite data and sketch out the road ahead.

[구 GC-18] Identifying Lensed Quasars and measuring their Time-Delays in Unresolved Systems

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Detecting lensed quasar systems and estimating their time delays using the unresolved joint light curves can be the next frontier among the cosmological probes in the near future. One can get the independent measurement of the Hubble constant from the time delays but without requiring the systems to be resolved a priori followed by monitoring the image light curves using high-resolution telescopes for years. In this work, we propose a novel technique that can identify lensed quasars only using the observed unresolved light curves and without assuming a template or any prior information. Following a set of conservative selection criteria that gives zero false-positive outcome, we can accurately estimate the time delay for almost all the lensed systems with marginal noise in the data. For the case of noisy data, our approach can still correctly identify a substantial number of lensed systems with high certainty and measure the time delay accurately.

[구 GC-19] Excursion-Set Modeling of the Splashback Mass Function and its Cosmological Usefulness (Splashback 질량함수의 Excursion-Set Modeling과 우주론적 유용성)

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일반화된 excursion set 이론과 자기 유사 구형 유입 (Self-similar spherical infall) 모형에 기반하여 Splashback 질량함수에 대한 해석적 단일 매개변수 모델을 착안하였다. Planck/WMAP7 관측결과를 토대로 구축된 EREBOS N-Body 시뮬레이션의 수치적 결과의 해석적 모델을 이용한 회귀분석을 통해 단일 매개변수이자 Splashback 경계의 확산적 특성을 수치화하는 확산계수 (Diffusion Coefficient)의 추정치를 계산하였다. 계산된

확산계수를 적용한 해석적 모델과 수치적 결과가 $5 \leq M/(10^{12}h^{-1}\ M_{\odot}) < 10^{3}$의 질량범위에서 매우 근접히 일치하는 것을 보였으며 Baysian and Akaike Information Criterion 검정을 통해 $0.3 \leq z \leq 3$의 범위에서 기존의 모델들보다 본 모델이 선호 돼야함을 확인하였다. 또한 확산계수가 적색편이에 대하여 선형진화에 근접한 변화를 보임을 발견하였으며, 특정 임계 적색편이(z_c)를 기준으로 확산계수가 0에 수렴함을 발견하였다. 더 나아가 두 Planck모델과 WMAP7모델에서 도출된 확산계수는 서로 상당한 차이를 보였다. 이 결과는 암흑물질 헤일로의 splashback 질량함수가 $z \geq z_c$에서 매개변수가 없는 온전한 해석적 모델로 설명되고 z_c가 독립적으로 우주의 초기조건을 독립적으로 특정지을 수 있는 가능성을 지님을 시사한다. 이 초록은 The Astrophysical Journal의 Ryu & Lee 2021, ApJ, 917, 98 (arxiv:2103.00730) 논문을 바탕으로 작성되었다.

[구 GC-20] Horizon Run Spin-off Simulations for Studying the Formation and Expansion history of Early Universe

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Horizon Run 5 (HR5) is a cosmological hydrodynamical simulation which captures the properties of the Universe on aGpc scale while achieving a resolution of 1kpc. This enormous dynamic range allows us to simultaneously capture the physics of the cosmic web on very large scales and account for the formation and evolution of dwarf galaxies on much smaller scales. On the back of a remarkable achievement of this, we have finished to run follow-up simulations which have 2 times larger volume than before and are expected to complementary to some limitations of previous HR simulations both for the study on the large scale features and the expansion history in a distant Universe. For these simulations, we consider the sub-grid physics of radiative heating/cooling, reionization, star formation, SN/AGN feedbacks, chemical evolution and the growth of super-massive blackholes. In order to do this project, we implemented a hybrid MPI-OpenMP version of the RAMSES code, 'RAMSES-OMP', which is specifically designed for modern many-core many thread parallel systems. These simulation successfully reproduce various observation result and provide a large amount of statistical samples of Lyman-alpha emitters and protoclusters which are important to understand the formation and expansion history of early universe. These are invaluable assets for the interpretation of current ΛCDM cosmology and current/upcoming deep surveys of the Universe, such as the world largest narrow band imaging survey, ODIN (One-hundred-square-degree Dark energy camera Imaging in Narrow band).

[구 GC-21] Horizon Run 5 Black Hole Populations and Pulsar Timing Array

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Merging of two supermassive black holes would generate gravitational waves that can be detected by the Pulsar Timing Array (PTA) in the nHz band. In order to assess the plausibility of GW detection with PTA and to develop the data analysis scheme, it is important to understand the underlying properties of black holes and black hole binaries. In this work, we present mass and redshift distributions of black hole mergers using the Horizon Run 5 (HR5) data and discuss their implications for GW detection. We find a general conjecture about the black hole merger tree is true with the Horizon Run 5. For example, a) relatively lighter black holes merge at higher redshifts and b) binary mergers do contribute to the formation of more massive black holes toward low redshifts. We also present our plan to use the black hole properties extracted from the HR5 data in order to generate simulated GW signals to be injected into actual PTA data analysis pipelines. Mass and distance obtained from the HR5 would be key ingredients to generate a more realistic PTA source data set.

[구 GC-22] STag: Supernova Tagging and Classification

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