density and the normalization parameters.

### [구 CO-04] HectoMAP and Horizon Run 4: Over- and Under-dense Large-scale Structures in the Real and Simulated Universe

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HectoMAP is a dense redshift survey of red galaxies covering a 53 square degree strip of the northern sky, and Horizon Run 4 is one of the densest and largest cosmological simulations based on the standard Lambda cold dark matter model. We use HectoMAP and Horizon Run 4 to compare the physical properties of observed large-scale structures with simulated ones in the redshift range $0.22<z<0.58$. We find that the properties of the largest over- and under-dense structures in HectoMAP are well within the distributions for the largest structures drawn from 300 Horizon Run 4 mock surveys. Overall the size, richness and volume distributions of observed large-scale structures when the universe is ~9.4 Gyrs old are remarkably consistent with predictions of the standard Lambda cold dark matter model.

### [구 CO-05] Lyman alpha radiative transfer at the epoch of cosmic reionization

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We present a numerical code for the random scattering histories of Lyman alpha photons in the intergalactic medium. The numerical code calculates the radiative transfer under generic three dimensional density, ionization fraction, and peculiar velocity fields based on N-body + radiation transfer simulations of the epoch of reionization. The code is tested with models having analytical solutions, which have idealized geometry and simplified velocity fields. The emergent line profiles can give constraints to the ionization structure around Lyman alpha sources in the early universe.

### [구 CO-06] Lagrangian Perturbation Theory for the Cosmological Structure Formation with 2-component Fluid

Kyungjin Ahn
*Chosun University*

We present the preliminary result of our Lagrangian perturbation theory for the large-scale structure formation, in the presence of the cold dark matter (CDM) and the baryonic fluid. In the linear order, two mutually independent pseudo-particles can describe the evolution of density fluctuations and the accuracy of the calculation is better than the 4-mode (growing, decaying, streaming, compensated) Eulerian linear perturbation theory. In the $2^{nd}$ order, the separability of pseudo-particles is not as straightforward as in the linear order, and the related difficulty in developing the $2^{nd}$ order theory will also be presented.

### [구 CO-07] Marked correlation function as modified gravity probe

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For modified gravity models with screening mechanisms, the signal of modified gravity is larger at low density areas. We could add a density weighted mark to galaxy correlation function and increase the signal to noise of modified gravity detection. Based on mock galaxy catalogs from modified gravity simulations, we try different mark functions and parameters to find the best choices for discreminating modified gravity from GR. In this talk I will present our marked correlation funciton results and discuss its advantages and disadvantages.

### [구 CO-08] Evidence for galaxy dynamics tracing background cosmology below the de Sitter scale of acceleration

Maurice H.P.M van Putten
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Galaxy dynamics probes weak gravity at accelerations below the de Sitter scale of acceleration adS = cH, where c is the velocity of light and H is the Hubble parameter. Low and high redshift galaxies hereby offer a novel probe of weak gravity in an evolving cosmology, satisfying H(z) = H0(1 + A(6z + 12z^2 +12z^3+ 6z^4+ (6/5)z^5)/(1 + z) with baryonic matter content A sans tension to H0 in surveys of the Local Universe. Galaxy rotation curves show anomalous galaxy dynamics in weak gravity aN <adS across a transition radius r beyond about 5 kpc for galaxy mass of 1e11 solar mass. where aN is the Newtonian acceleration based on baryonic matter content. We identify this behavior with a holographic origin of inertia from entanglement entropy, that introduces a C0 onset across aN=adS with asymptotic behavior described by a Milgrom parameter satisfying a0=omega/(2pi), where omega=sqrt(1-q)H is a fundamental eigenfrequency of the cosmological horizon. Extending an earlier confrontation with data covering 0.003< aN/adS < 1 at redshift z about zero in Lellie et al. (2016), the modest anomalous behavior in the Genzel et al. sample at redshifts 0.854< z <2.282 is found to be mostly due to clustering 0.36 < aN/adS < 1 close to the C0 onset to weak gravity and an increase of up to 65% in a0.

### [구 CO-09] Cosmological Gas in RAMSES

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The distribution of gas on cosmological scales is vital to our understanding of galaxy formation. Using the RAMSES cosmological hydrodynamical simulation code we have explored the evolution of the gas properties in a cosmological volume. We have identified the effect of the maximum simulation force resolution, and the resolution of the initial conditions, on the gas density power spectrum, as well as artefacts due to the RAMSES algorithm. The RAMSES methodology can add spurious power on small scales, particularly in low resolution simulations. This effect can be expected to have a strong impact on the results of RAMSES simulations, because this additional power appears at specific epochs, implying a sudden change to the system.

### [구 CO-10] Effects of large-scale structures on cosmological hydrodynamic simulations

Jihye Shin, Changbom Park, and Juhan Kim
*Korea Institute for Advanced Study*

We in the Korea Institute for Advanced Study are preparing the fifth Horizon Run in a series of large-scale cosmological simulations. For the first time we will include full hydrodynamics and astrophysical processes using a RAMSES code. I will discuss the impact of large-scale structures on smaller scale properties in cosmological hydrodynamic simulation to justify our choice of simulation boxsize, whose one side length is up to 1 Gpc.

## 천문우주관측기술

### [구 AT-01] Breakthrough Starshot Project: Could Relativistic Spacecraft Make it to Alpha Centauri?

Thiem Hoang
*Korea Astronomy and Space Science Institute & Korea University of Science and Technology*

The Breakthrough Starshot initiative aims to launch gram-scale spacecraft to a speed of v~0.2c, capable of reaching Alpha Centauri and seeing the Earth-like exoplanet, Proxima b, from close distance, in about 20 years. However, a critical challenge for the initiative is the effects of interstellar matter and magnetic field to the relativistic spacecraft during the journey. In this talk, I will first present our evaluation for the damage to the spacecraft by interstellar gas and dust based on a detailed analysis of the interaction of a relativistic spacecraft with the ISM. Second, I will discuss the deflection and oscillation of spacecraft by interstellar magnetic fields.

Third, I will discuss the gas drag fore at high energy regime and quantify its effect on the slowing down of the relativistic lightsails. Finally, we will discuss practical strategies to mitigate the damage by interstellar dust and to maintain the spacecraft aiming at the intended target.

### [구 AT-02] Critical Design Status of the G-CLEF Flexure Control Camera

Jae Sok Oh[1], Chan Park[1], Kang-Min Kim[1],