gravitational waves and electromagnetics waves from the merging of neutron stars opened up multi-messenger astronomy. The forthcoming observations with better sensitivity by the network of ground based detectors will enrich the gravitational wave source populations and provide valuable information regarding stellar evolution, dynamics of dense stellar systems, and star formation history across the cosmic time. The precision of the Hubble constant from the distance measurement of gravitational sources will improve with more binary neutron star events are observed together with the aftweglows. I will also briefly cover the expected scientiic outcomes from the future detectors that are sensitive to much lower frequenies than current detectors.

외부은하 / 은하단

[구 GC-01] Statistical Analysis of Interacting Dark Matter Halos: On two physically distinct interaction types

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We present a statistical analysis of dark matter halos with interacting neighbors using a set of cosmological simulations. We classify the neighbors into two groups based on the total energy (E_{12}) of the target−neighbor system; *flybying* neighbors ($E_{12} \geq 0$) and *merging* ones ($E_{12} < 0$). First, we find a different trend between the flyby and merger fractions in terms of the halo mass and large-scale density. The flyby fraction highly depends on the halo mass and environment, while the merger fraction show little dependence. Second, we measure the spin−orbit alignment, which is the angular alignment between the spin of a target halo ($\vec{S}$) and the orbital angular momentum of its neighbor ($\vec{L}$). In the spin−orbit angle distribution, the flybying neighbors show a weaker prograde alignment with their target halos than the merging neighbors do. With respect to the nearest filament, the flybying neighbor has a behavior different from that of the merging neighbor. Finally, we discuss the physical origin of two interaction types.

[구 GC-02] Dual effects of ram pressure on star formation in multiphase disk galaxies with strong stellar feedback

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We investigate the impact of ram pressure stripping due to the intracluster medium (ICM) on star-forming disk galaxies with a multiphase interstellar medium maintained by strong stellar feedback. We carry out radiation-hydrodynamic simulations of an isolated disk galaxy embedded in a 1011 M⊙ dark matter halo with various ICM winds mimicking the cluster outskirts (moderate) and the central environment (strong). We find that both star formation quenching and triggering occur in ram pressure-stripped galaxies, depending on the strength of the winds. HI and H2 in the outer galactic disk are significantly stripped in the presence of moderate winds, whereas turbulent pressure provides support against ram pressure in the central region, where star formation is active. Moderate ICM winds facilitate gas collapse, increasing the total star formation rates by ∼40% when the wind is oriented face-on or by ∼80% when it is edge-on. In contrast, strong winds rapidly blow away neutral and molecular hydrogen gas from the galaxy, suppressing star formation by a factor of 2 within ∼200 Myr. Dense gas clumps with nH≳10 M⊙ pc-2 are easily identified in extraplanar regions, but no significant young stellar populations are found in such clumps. In our attempts to enhance radiative cooling by adopting a colder ICM of T=106K only a few additional stars are formed in the tail region, even if the amount of newly cooled gas increases by an order of magnitude.

[구 GC-03] The Origin of the Spin−Orbit Alignment of Galaxy Pairs

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Galaxies are not just randomly distributed in space; instead, a variety of galaxy alignments have been found over a wide range of scales. Such alignments are the outcome of the combined effect of interacting neighbors and the surrounding large-scale structure. Here, we focus on the spin−orbit alignment (SOA) of galaxy pairs, the dynamical coherence between the spin of a target galaxy and the orbital angular momentum of its neighbor. Based on a recent cosmological hydrodynamic simulation, the IllustrisTNG project, we identify paired galaxies with mass ratios from 1/10 to 10 at z = 0 and statistically analyze their

spin–orbit angle distribution. We find a clear preference for prograde orientations (i.e., SOA), which is more prominent for closer pairs. The SOA is stronger for less massive targets in lower-density regions. The SOA witnessed at z = 0 has been developed progressively since z = 2. There is a clear positive correlation between the alignment strength and the interaction duration with its current neighbor. Our results suggest the scenario in which the SOA is developed mainly by interactions with a neighbor for an extended period of time, rather than by the primordial torque exerted by the large-scale structure.

[구 GC-04] Star-Gas Misalignment in Galaxies: II. Origins Found from the Horizon-AGN Simulation

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There have been many studies aiming to reveal the origins of the star-gas misalignment found in galaxies, but there still is a lack of understanding of the contribution from each formation channel candidate. We explore the properties, origins, and lifetimes of the star-gas misalignment using Horizon-AGN, a large-volume cosmological simulation. First, the misalignment fraction shows a strong anti-correlation with the kinematic morphology (V/sigma) and the cold gas fraction of the galaxy. This result is consistent with the result of integral field spectroscopy observations. Second, we have identified four main formation channels of misalignment and quantified their level of contribution: mergers (35%), interaction with nearby galaxies (23%), interaction with dense environments or their central galaxies (21%), and secular evolution including smooth accretion from neighboring filaments (21%). Third, the decay timescale of the misalignment is strongly linked with the kinematic morphology of the galaxy: early-type galaxies (2.28 Gyr) tend to have a longer misalignment lifetime than LTGs (0.49 Gyr). We also found that the morphology and cold gas fraction are both and independently anti-correlated with the misalignment lifetime.

[구 GC-05] Cosmological N-body simulations for Intracluster Light using the Galaxy Repacement Technique

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Intracluster light (ICL) is composed of the stars diffused throughout the galaxy cluster but does not bound to any galaxy. The ICL is a ubiquitous feature of galaxy clusters and occupies a significant fraction of the total stellar mass in the cluster. Therefore, the ICL components are believed to help understand the formation and evolution of the clusters. However, in the numerical study, one needs to perform the high-resolution cosmological hydrodynamic simulations, which require an expensive calculation, to trace these low-surface brightness structures (LSB). Here, we introduce the Galaxy Replacement Technique (GRT) that focuses on implementing the gravitational evolution of the diffused ICL structures without the expensive baryonic physics. The GRT reproduces the ICL structures by a multi-resolution cosmological N-body re-simulation using a full merger tree of the cluster from a low-resolution DM-only cosmological simulation and an abundance matching model. Using the GRT, we show the preliminary results about the evolution of the ICL in the on-going simulations for the various clusters.

[구 GC-06] Particle Tagging Method to Study the Formation and Evolution of Globular Clusters in Galaxy Clusters

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Globular clusters (GCs) form at the very early stage of galaxy formation, and thus can be used as an important clue indicating the environment of the galaxy formation era. Although various GC formation scenarios have been suggested, they have not been examined in the cosmological context. Here we introduce the ‘particle tagging method’ in order to investigate the formation scenarios of GCs in a galaxy cluster. This method is able to trace the evolution of GCs that form in the dark matter halos which undergo the hierarchical merging events in galaxy cluster environments with an effective computational time. For this we use dark matter merger trees from the cosmological N-body simulation. Finally, we would like to find out the best GC formation scenario which can explain the observational properties of GCs in galaxy clusters.