early-type spirals, whereas SABs are in late-type spirals. Moreover, the ellipse fitting method often misses strongly barred galaxies in the bulge-dominated galaxies. These explain why previous works showed the contradictory dependence of the bar fraction on the host galaxy properties. Our new method has the highest agreement with visual inspection in terms of the individual classification and the overall bar fraction. In addition, we find another signature on the ratio map to classify barred galaxies into new two classes that are probably related to the age of the bar.

[구 GC-02] A Numerical Study of Stellar Bars and Nuclear Rings in Barred Galaxies

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To study the formation and evolution of stellar bars and gaseous nuclear rings in barred galaxies in realistic environments, we run fully self-consistent three-dimensional simulations of isolated disk galaxies. We consider two groups of models with cold or warm disks that differ in the radial velocity dispersion. We also vary the gas fraction of the disks. We found that a bar forms earlier and more strongly as the gas fraction increases in the cold disks, while the gas delays the bar formation in the warm disks. The bar formation enhances a central mass concentration which in turn weakens the bar strength temporarily, after which the bar regrows to become stronger in a model with a smaller gas fraction in both cold and warm disks. Although all bars rotate fast in the beginning, they rapidly turn to slow rotators. Gas infalling to the central region forms a dense star-forming nuclear ring. The ring size is very small when it first forms and grows over time. The ring star formation is episodic and bursty due to star formation feedback, and has a good correlation with the mass inflow rate to the ring. Some expanding shells produced by star formation feedback are sheared out in the bar regions and collide with dust lanes to appear as filamentary interbar spurs.

[구 GC-03] Spiral Arm Features in Disk Galaxies: A Density-Wave Theory

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Several observational results show a tighter pitch angle at wavelengths of optical and near-infrared than those that are associated with star formation, which is in agreement with the prediction of the density wave theory. In my recent numerical studies, the dependence of the shock positions relative to the potential minima is due to the tendency that stronger shocks form farther downstream. This causes a systematic variation of the perpendicular Mach number, with radius and makes the pitch angle of the gaseous arms smaller than that of the stellar arms, which supports the prediction of the density-wave theory, independently. However, some observations still give controversial results which show similar pitch angles at wavelengths, and there is no statistical study comparing observations and numerical models directly. By analyzing optical image of disk galaxies in the Carnegie-Irvine Galaxy Survey (CGS), I measured the physical values of stellar and gaseous arms such as their strength, length, and pitch angles. For direct comparison with numerical results, I analyzed more than 30 additional numerical models with varying the initial parameters in model galaxies. In this talk, I will present results both of observational and numerical samples and discuss the physical properties of spiral structures based on the density-wave theory.

[구 GC-04] Galaxy Rotation Coherent with the Average Motion of Neighbors

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We report our discovery of observational evidence for the coherence between galaxy rotation and the average motion of neighbors. Using the Calar Alto Legacy Integral Field Area (CALIFA) survey data analyzed with the Python CALIFA STARLIGHT Synthesis Organizer (PyCASSO) platform, and the NASA-Sloan Atlas (NSA) catalog, we estimate the angular momentum vectors of 445 CALIFA galaxies and build composite maps of their neighbor galaxies on the parameter space of velocity versus distance. The composite radial profiles of the luminosity-weighted mean velocity of neighbors show striking evidence for dynamical coherence between the rotational direction of the CALIFA galaxies and the average moving direction of their neighbor galaxies. The signal of such dynamical coherence is significant for the neighbors within 800 kpc distance from the CALIFA galaxies with a confidence level of 3.5σ, when the angular momentum is measured at the outskirt ($Re<R\leq 2Re$) of each CALIFA galaxy. We also find that faint or kinematically misaligned galaxies show stronger coherence with neighbor motions than

bright or kinematically well-aligned galaxies do. Our results show that the rotation of a galaxy, particularly at its outskirt, may be significantly influenced by recent interactions with its neighbors.

[구 GC-05] The Spin-Orbit Alignment of Dark Matter Halo Pairs: Dependence on the Halo Mass and Environment

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We present a statistical analysis on the spin-orbit alignment of dark matter halo pairs in cosmological simulations. The alignment is defined as the angular concurrence between the halo spin vector ($\vec{S}$) and the orbital angular momentum vector ($\vec{L}$) of the major companion. We identify interacting halo pairs with the mass ratios from 1:1 to 1:3, with the halo masses of $10.8 < \mathrm{Log}(M_{\mathrm{halo}}/M_{\mathrm{sun}}) < 13.0$, and with the separations smaller than a sum of their virial radii ($R_{12} < R_{1,\mathrm{vir}} + R_{2,\mathrm{vir}}$). Based on the total energy (E_{12}), the pairs are classified into flybys ($E_{12} > 0$) and mergers ($E_{12} \leq 0$). By measuring the angle (θ_{SL}) between $\vec{S}$ and $\vec{L}$, we confirm a strong spin-orbit alignment signal such that the halo spin is preferentially aligned with the orbital angular momentum of the major companion. We find that the signal of the spin-orbit alignment for the flyby is weaker than that for the merger. We also find an unexpected excess signal of the spin-orbit alignment at $\cos\theta_{\mathrm{SL}} \sim 0.25$. Both the strength of the spin-orbit alignment and the degree of the excess depend only on the environment. We conclude that the halo spin is determined by the accretion in a preferred direction set by the ambient environment.

[구 GC-06] Detection of Intrinsic Spin Alignments in Isolated Spiral Pairs

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Observational evidence for intrinsic galaxy alignments in isolated spiral pairs is presented. From the catalog of the galaxy groups identified by Tempel et al. in the flux-limited galaxy sample of the Sloan Digital Sky Survey Data Release 10, we select those groups consisting only of two spiral galaxies as isolated spiral pairs and investigate if and how strongly the spin axes of their two spiral members are aligned with each other. We detect a clear signal of intrinsic spin alignment in isolated spiral pairs, which leads to the rejection of the null hypothesis at the 99.9999% confidence level via the Rayleigh test. It is also found that those isolated pairs comprising two early-type spiral galaxies exhibit the strongest signal of intrinsic spin alignment and that the strength of the alignment signal depends on the angular separation distance as well as on the luminosity ratio of the member galaxies. Using the dark matter halos consisting of only two subhalos resolved in the EAGLE hydrodynamic simulations, we repeat the same analysis but fail to find any alignment tendency between the spin angular momentum vectors of the stellar components of the subhalos, which is in tension with the observational result. Several possible sources of this apparent inconsistency between the observational and the numerical results are discussed.

[석 GC-07] Understanding the physical environment of relativistic jet from 3C 279 using its spectral and temporal information

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Blazars are a subclass of active galactic nuclei (AGNs) with relativistic jets aligned with our line of sight. The jet physics is yet to be understood, but can be studied with blazar variability (e.g., flares). The highly variable blazar 3C 279 has shown a general decline of its radio flux density since 2013, but the flux density has been increasing since 2017. To better understand physical properties of 3C 279 related with the flux variations, we analyze multi-frequency new radio data obtained with Korean VLBI Network (KVN), as well as archival data from Owens Valley Radio Observatory (OVRO) and Submillimeter Array (SMA). We measure the radio spectral variability and infer the relativistic jet properties of 3C 279. The high-cadence OVRO and SMA observations are used to construct detailed light curves of the source, and KVN data supplement the spectral coverage and allow us to locate the spectral break frequencies precisely. In this talk, we present our analysis results and interpret them using a blazar jet model.

[구 GC-08] BAT AGN Spectroscopic Survey – The parsec scale jet properties of the ultra hard X-ray selected local AGNs