opened a new way of exploring the universe, namely, multi-messenger astronomy (MMA). One of the keys to the success of MMA is a rapid identification of EM counterpart.

We will introduce GW follow-up observation project in Korea for hunting GW EM counterpart rapidly and its strategy for prioritization of GW source host galaxy candidates. Our method relies on recent simulation results regarding plausible properties of GW source host galaxies and the low latency localization map from LIGO/Virgo. We will show a test result for both binary neutron star merger events using previous event and describe observing strategy with our facilities for GW events during the ongoing LIGO/Virgo O3 run. Finally, we report the results of optical/NIR follow-up observation of GW190425, the first neutron

[구 GC-23] Gamma-Ray and Neutrino Emissions from Starburst Galaxies

Ji-Hoon Ha[1], Dongsu Ryu[1] and Hyesung Kang[2]
[1]Department of Physics, School of Natural Sciences UNIST, Ulsan 44919, Korea
[2]Department of Earth Sciences, Pusan National University, Busan 46241, Korea

Cosmic-ray protons (CRp) are efficiently produced at starburst galaxies (SBGs), where the star formation rate (SFR) rate is high. In this talk, we present estimates of gamma-ray and neutrino emissions from nearby SBGs, M82, NGC253, and Arp220. Inside the starburst nucleus (SBN), CRp are accelerated at supernova remnant (SNR) shocks as well as at stellar wind (SW) termination shocks, and their transport is governed by the advection due to starburst-driven wind and diffusion mediated by turbulence. We here model the momentum distributions of SNR and SW-produced CRp with single or a double power-law forms. We also employ two different diffusion models, where CRp are resonantly scattered off large-scale turbulence in SBN or self-excited waves driven by CR streaming instability. We then calculate gamma-ray/neutrino fluxes. The observed gamma-ray fluxes by Fermi-LAT, Veritas, and H.E.S.S are well reproduced with double power-law distribution for SNR-produced CRp and the CRp diffusion by self-excited turbulence. The estimated neutrino fluxes are <~10-3 of the atmospheric neutrino flux in the energy range of Eneutrino <~100 GeV and <~10-1 of the IceCube point source sensitivity in the energy range of Eneutrino >~60 TeV.

[구 GC-24] Morphology and Dynamical Properties of Ultra-Relativistic Jets

Jeongbhin Seo[1], Hyesung Kang[1], Dongsu Ryu[2]
[1]Pusan National University, [2]Ulsan Institute of Science and Technology

We study the structures and dynamics of flows generated by ultra-relativistic jets on kpc scales through three-dimensional relativistic hydrodynamics (RHD) simulations. We employ a newly developed RHD code, equipped with the WENO-Z reconstruction, the SSPRK time discretization, and an equation of state that closely approximates the single-component perfect gas in relativistic regime. Exploring a set of models with various parameters, we confirm that the well-known Fanaroff-Riley dichotomy is primarily determined by the jet power, whereas the morphology of simulated jets also depends on the secondary parameters such as the momentum injection rate and the ratio of the jet to background pressure. Utilizing high resolution capabilities of the newly developed code, we examine in detail the dynamical properties of complex flows in different parts of jet-produced structures, and present the statistics of nonlinear dynamics such as shock, shear, and turbulence.

[구 GC-25] On the origin of the thick discs of spiral galaxies from high-resolution cosmological simulations

Sukyoung K. Yi[1], Min-Jung Park[1], Sebastien Peirani[2], Christophe Pichon[3], Yohan Dubois[3], Hoseung Choi[1], Julien Devriendt[4], Taysun Kimm[1], Sugata Kaviraj[5], Katarina Kraljic[6], Marta Volonteri[3]
[1]Yonsei University,
[2]Observatoire de la Côte d'Azur,
[3]Institut d'Astrophysique de Paris,
[4]University of Oxford,
[5]University of Hertfordshire
[6]University of Edinburgh

Ever since thick disk was proposed to explain the vertical distribution of the Milky Way disk stars, its origin has been a recurrent question. We aim to answer this question by inspecting 19 disk galaxies with stellar mass greater than 10^10 solar mass in recent cosmological high-resolution (>34 pc) zoom-in simulations: Galactica and New Horizon. The thin and thick disks are reproduced by the simulations with scale heights and luminosity ratios that are in reasonable agreement with observations. When we spatially classify the disk stars into thin and thick disks by their heights from the galactic plane, the ``thick'' disk stars are older, less metal-rich, kinematically hotter, and higher in accreted star fraction than the ``thin'' disk counterparts. However, we found that the the thick disk stars were spatially and kinematically

thinner when they were born. Indeed, a large fraction of thick disk stars was born near the galactic plane at earlier times and get heated with time, eventually occupying high altitudes and exhibiting different population properties compared to the thin-disk stars. In conclusion, from our simulations, the thin and thick disk components are not entirely distinct at birth, but rather a result of the time evolution of the stars born in the main disk of the galaxy. (excerpted from the abstract of the upcoming paper submitted to Astrophysical Journal: Park, M.-J., Yi, S.K. et al. 2020)

[구 GC-26] Star-gas misalignment in galaxies: I. the properties of galaxies from the Horizon-AGN simulation and comparisons to SAMI

Donghyeon J. Khim, Sukyoung K. Yi, the Horizon-AGN team, and the SAMI team
Department of Astronomy and Yonsei University Observatory, Yonsei University, Seoul 03722, Republic of Korea

Recent integral field spectroscopy observations have found that about 11% of galaxies show star-gas misalignment. The misalignment possibly results from external effects such as gas accretion, interaction with other objects, and other environmental effects, hence providing clues to these effects. We explore the properties of misaligned galaxies using Horizon-AGN, a large-volume cosmological simulation, and compare the result with the result of the Sydney-AAO Multi-object integral field spectrograph (SAMI) Galaxy Survey. Horizon-AGN can match the overall misalignment fraction and reproduces the distribution of misalignment angles found by observations surprisingly closely. The misalignment fraction is found to be highly correlated with galaxy morphology both in observations and in the simulation: early-type galaxies are substantially more frequently misaligned than late-type galaxies. The gas fraction is another important factor associated with misalignment in the sense that misalignment increases with decreasing gas fraction. However, there is a significant discrepancy between the SAMI and Horizon-AGN data in the misalignment fraction for the galaxies in dense (cluster) environments. We discuss possible origins of misalignment and disagreement. This presentation is mainly based on the published work Khim et al. 2020, ApJ, 894, 106 (17pp).

[구 GC-27] The Horizon Run 5 Cosmological Hydrodynamical Simulation: Probing Galaxy Formation from Kilo- to Giga-parsec Scales

Jaehyun Lee[1], Jihey Shin[2], Owain N. Snaith[3], Yonghwi Kim[1], C. Gareth Few[4,5], Julien Devriendt[6], Yohan Dubois[7], Leah M. Cox[4], Sungwook E. Hong[8], Oh-Kyoung Kwon[9], Chan Park[10], Christophe Pichon[1,7], Juhan Kim[1], Brad K. Gibson[4], and Changbom Park[1]
[1]Korea Institute for Advanced Study
[2]Korea Astronomy and Space Science Institute
[3]Observatoire de Paris
[4]University of Hull
[5]Durham University
[6]University of Oxford
[7]CNRS and Sorbonne Universite
[8]University of Seoul
[9]Korea Institute of Science and Technology Information
[10]National Institute for Mathematical Science

Horizon Run 5 (HR5) is a cosmological hydrodynamical simulation which captures the properties of the Universe on a Gpc scale while achieving a resolution of 1 kpc. 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. Inside the simulation box. we zoom-in on a high-resolution cuboid region with a volume of 1049 × 114 × 114 Mpc3 . The subgrid physics chosen to model galaxy formation includes radiative heating/cooling, reionization, star formation, supernova feedback, chemical evolution tracking the enrichment of oxygen and iron, the growth of supermassive black holes and feedback from active galactic nuclei (AGN) in the form of a dual jet-heating mode. For this simulation we implemented a hybrid MPI-OpenMP version of the RAMSES code, specifically targeted for modern many-core many thread parallel architectures. For the post-processing, we extended the Friends-of-Friend (FoF) algorithm and developed a new galaxy finder to analyse the large outputs of HR5. The simulation successfully reproduces many observations, such as the cosmic star formation history, connectivity of galaxy distribution and stellar mass functions. The simulation also indicates that hydrodynamical effects on small scales impact galaxy clustering up to very large scales near and beyond the baryonic acoustic oscillation (BAO) scale. Hence, caution should be taken when using that scale as a cosmic standard ruler: one needs to carefully understand the corresponding biases. The simulation is expected to be an invaluable asset for the interpretation of upcoming deep surveys of the Universe.