

of various black hole binaries, we performed the code sanity check and performance test. In this talk, we present the situation of GW observation with the Covid-19 pandemic. In addition to preliminary PE results with the KAGALI MCMC PE pipeline, we discuss how we can optimize a CBC PE pipeline toward the next observation run.

## 고에너지천문학/이론천문학

### [구 HT-01] Test-particle Solutions for Electron Acceleration in Low Mach Number Shocks

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We propose semi-analytic models for the electron momentum distribution in weak shocks that accounts for both in situ acceleration and re-acceleration through diffusive shock acceleration (DSA). In the former case, a small fraction of incoming electrons is assumed to be reflected at the shock ramp and pre-accelerated to the so-called injection momentum,  $p_{inj}$ , above which particles can diffuse across the shock transition and participate in the DSA process. This leads to the DSA power-law distribution extending from the smallest momentum of reflected electrons,  $p_{ref}$ , all the way to the cutoff momentum,  $p_{eq}$ , constrained by radiative cooling. In the latter case, fossil electrons, specified by a power-law spectrum with a cutoff, are assumed to be re-accelerated from  $p_{ref}$  up to  $p_{eq}$  via DSA. We show that, in the in situ acceleration model, the amplitude of radio synchrotron emission depends strongly on the shock Mach number, whereas it varies rather weakly in the re-acceleration model.

### [구 HT-02] Microinstabilities at Quasi-Perpendicular Shocks in the High- $\beta$ ICM

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At quasi-perpendicular shocks in the high- $\beta$  ( $\beta = P_{gas}/P_{mag} \sim 100$ ) intracluster medium (ICM), various microinstabilities occur by the temperature

anisotropies and/or drift motions of plasma. In the downstream, the Alfvén ion cyclotron instability (AIC) due to the ion temperature anisotropy ( $T_{i\perp} > T_{i\parallel}$ ) is triggered by shock-reflected ions, the whistler instability (WI) is driven by the electron temperature anisotropy ( $T_{e\perp} > T_{e\parallel}$ ) as a consequence of the shock compression of magnetic fields, and the mirror instability is generated due to the ion and/or electron temperature anisotropy. At the shock foot, the modified two stream instability (MTSI) is possibly excited by the cross-field drift between ions and electrons. In the upstream, electron firehose instability (EFI) is driven by the electron temperature anisotropy or the relative drift between incoming and reflected electrons. These microinstabilities play important roles in the particle acceleration in ICM shocks, so understanding of the microinstabilities and the resultant plasma waves is essential. In this study, based on a linear stability analysis, the basic properties of the microinstabilities in ICM shocks and the ion/electron scale fluctuations are described. We then discuss the implication of our work on the electron pre-acceleration in ICM shocks.

### [구 HT-03] Turbulence Dynamo in Compressively Driven Fluids

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천문학적 유체는 강하게 자화되어 있는 경우가 많은데, 이러한 강한 자기장을 얻는 한 방법이 난류에 의한 자기장의 증폭이다. 플라즈마 효과나 기타의 이유로 약한 씨앗 자기장이 유체에 생길 경우, 난류는 이 씨앗 자기장을 매우 효과적으로 증폭시킬 수가 있다. 이 과정을 난류 다이내모라 하는데, 난류 다이내모는 주로 비압축성 난류 구동력을 사용하여 연구해 오고 있다. 비압축성 구동력을 사용할 때의 난류 다이내모 과정은 비교적 잘 규명되어 있다. 기존의 연구 결과에 의하면, 자기장의 세기는 지수 함수적 성장을 거친 후 선형적 성장 단계를 겪는다. 이후, 자기장의 에너지 밀도가 난류의 에너지 밀도와 비슷해지면 자기장은 더 이상 성장하지 못하고 포화 상태에 접어든다. 결론적으로 난류는 자기장이 동력학적으로 중요한 수준까지 증폭을 시킬 수 있다. 압축성 난류 구동력을 사용한 난류 다이내모 연구도 일부 존재하는데, 기존의 연구 결과에 의하면 다이내모 효과가 비압축성 구동력의 경우보다 비효율적이다. 본 연구에서는 압축성 구동력을 사용하여 난류 다이내모를 체계적으로 연구하였다. 특히 압축성 구동력과 비압축성 구동력이 난류 다이내모 효과에 어떤 차이를 주는지 체계적으로 비교하였다.

### [구 HT-04] ERotating Bondi Accretion Flow with and without outflow

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It is less well known that the properties, especially the mass accretion rate, of accretion flow are affected by the angular momentum of accreting gas. Park (2009) found that the mass accretion rate  $\dot{m}$ , mass accretion rate in units of Bondi accretion rate, is inversely proportional to the angular momentum of gas  $\lambda$ , at the Bondi radius where gas sound speed is equal to the free-fall velocity and proportional to the viscosity parameter  $\alpha$ , and also Narayan & Fabian (2011) found a similar relation, but the dependence of the mass accretion rate of the gas angular momentum is much weaker. In this work, we investigate the global solutions for the rotating Bondi flow, i.e., polytropic flow accreting via viscosity, for various accretion parameters and the dependence of the mass accretion rate on the physical characteristics of gas. We set the outer boundary at various radius  $r_{\text{out}}=10^3\sim 10^5 r_{\text{Sch}}$ , where  $r_{\text{Sch}}$  is the Schwarzschild radius of the black hole. For a small Bondi radius, the mass accretion rate changes steeply, as the angular momentum changes, and for a large Bondi radius, the mass accretion rate changes gradually. When the accreting gas has a near or super Keplerian rotation, we confirm that the relation between the mass accretion rate and angular momentum is roughly independent of Bondi radius as shown in Park (2009). We find that  $\dot{m}$  is determined by the gas angular momentum at the Bondi radius in units of  $r_{\text{Sch}}c$ . We also investigate the solution for the rotating Bondi flow with the outflow. The outflow affects the determination of the mass accretion rate at the outer boundary. We find that the relation between the mass accretion and the gas angular momentum becomes shallower as the outflow strengthens.

**[구 HT-05] Herschel/PACS spectroscopy of the supernova remnant G21.5-0.9**

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We present Herschel Space Observatory far-IR observations of the supernova remnant(SNR) G21.5-0.9. We search PACS-IFU data for 63um [O I], 88um [O III], 157um [C II] emission lines and detect the [O II] and the [C II]. We then produce emission line maps to check the spatial distribution of the elements. We compare the maps to Radio,

IR-photometrics, and X-ray images in order to understand interaction of the ejecta with the Pulsar Wind Nebula(PWN) and physical environment in the SNR.

**[구 HT-06] X-RAY PROPERTIES OF THE PULSAR PSR J0205+6449 IN 3C 58**

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We measure X-ray timing and spectral properties of the pulsar PSR J0205+6449. Pulsar's rotation frequency  $\nu = 15.20102357(9) \text{ s}^{-1}$  and its derivative  $\dot{\nu} = -4.5(1) \times 10^{-11} \text{ s}^{-2}$  are measured, and the pulsed spectrum of 2-30 keV is model of power law with photon index  $\Gamma_{\text{psr}} = 1.07(16)$  and  $F_{2-30 \text{ keV}} = 7.3(6) \times 10^{-13} \text{ erg cm}^{-2} \text{ s}^{-1}$ . We use thermal emission models and non-thermal model to fit the pulsar spectrum and measure the surface temperature and luminosity of the pulsar. The surface temperature  $T_{\infty} = 0.5\text{-}0.8 \text{ MK}$  and luminosity  $L_{\text{th}} = 1\text{-}5 \times 10^{32} \text{ erg s}^{-1}$  are measure, and this result verifies the previous results known to have low surface temperature and luminosity for the age range of

**고천문**

**[구 HT-07] Solar motion described in the Richan lizhi(日躔曆指) and the Richan biao(日躔表) of the Chongzhen reign treatises on Calendrical Astronomy(Chongzhen lishu 崇禎曆書)**

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본 연구는 명말(明末)에 역법(歷法)의 개정을 주장한 서광계(徐光啓, 1562~1633)의 기획과 총괄에 의해 편찬되었고, 이탈리아 선교사 로(Giacomo Rho, 羅雅谷, 1593~1638)가 주 저자로 보는 《송정역서》에서 태양의 이론편인 <일전역지(日躔曆指)>와 계산 절차 및 계산수치표가 종합된 <일전표(日躔表)>의 내용을 정리, 분석하였다.