博 士 論 文 公 聴 会

ご 案 内

下記の要領で博士論文公聴会を開催します。皆様のご来聴をお待ちしております。
部屋の換気等、新型コロナウイルス感染症拡大防止に留意しつつ、対面で行います。ご来聴の方はマスクの着用をお願いいたします。

記

日　時 ： ２０２３年１１月１５日（水）１６：５０～１８：２０

場　所 ： Ｆ６０８号室

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題　目 ：Cold stream properties in the circumgalactic medium: the role of magnetic field and thermal conduction
（銀河周辺物質中でのコールドストリームの性質: 磁場と熱伝導の役割）

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論文要旨 ：

Background：Galaxy formation and evolution is a challenging field linking the early state of our Universe that is imprinted in the cosmic microwave background to the Milky Way and the numerous observed nearby galaxies.

Current state-of-the-art cosmological simulations reproduce relatively well important galaxies’ properties such as the two distinct populations in the nearby galaxies or the cosmic star formation history. Moreover, cosmological simulations unveil a physical key mechanism behind the galaxies’ properties：the cold stream scenario. In the early Universe (z≥2) galaxies are predicted to acquire most of the fuel of their star formation via cold streams of gas with temperature 104 K flowing along the potential of the cosmic web. Despite the ubiquitous nature of this scenario from cosmological simulations, the current simulations’ accuracy is insufficient to fully capture the stability and Lyα emission properties of these cold streams. Deciphering the characteristic emission of the cold streams is essential to fully understand the numerous observed Lyα emitters.

Method：To answer this challenge, recent efforts focused on idealized high-resolution hydrodynamics (HD) simulations. Our research follows this current trend by performing a large suite of 2D magneto-HD (MHD) simulations assessing for the first time how magnetic fields at various angles and anisotropic thermal conduction (TC) influence the dynamics of radiatively cooling cold streams. Those simulations are performed using the astrophysical code Athena++ on which we implemented the anisotropic thermal conduction module.

Results：We find that an initially small magnetic field strength of approximately 10−3 μG, with a field oriented non-parallel to the stream, undergoes significant growth. The amplification of the field increases the stability of the stream against Kelvin-Helmholtz instabilities and reduces Lyα emissions by a factor of less than 20 compared to the hydrodynamics scenario. The inclusion of anisotropic thermal conduction (TC) categorizes the stream evolution into three distinct regimes：(1) the diffusing stream regime, where the stream diffuses into the surrounding hot circumgalactic medium; (2) the intermediate regime, characterized the mixing layer diffusion, leading to increased stability and reduced Lyα emissions; (3) the condensing stream regime, where the influence of magnetic fields and TC on the stream's emission and evolution is negligible. Extrapolating these findings to a cosmological context suggests that cold streams with a radius of ≤1 kpc may serve as a prolonged source of cold, metal-enriched, magnetized gas (with magnetic field strengths in the range of 0.1 to 1 μG) for massive galaxies in the early Universe. This, in turn, results in a broad spectrum of Lyα luminosity signatures ranging from approximately 1037 up to 1041 erg s−1.