２０２４年度

（９月修了）

修士論文発表会

論文要旨集

２０２４年8月１６日（金）

Contribution to the cosmic γ-ray background radiation from star-forming galaxies 星形成銀河の宇宙ガンマ線背景放射への寄与

35-226366 CHEN Junling

July 2024

Abstract

Star-forming galaxies(SFGs) produce high energy cosmic ray(CR) protons and leptons by supernova explosion. These CRs produce γ-ray photons via interactions with the environment within the galaxy. The γ-ray emission from SFGs forms an important component of isotropic diffuse γ-ray background(IGRB). In this work, we calculate the contribution from SFGs to the 0.01-820 GeV IGRB. We construct our model in a physical way instead of an empirical way and calibrate the model with the observational data of nearby galaxies. Our model describe several γ-ray emission mechanisms within SFGs in detail, especially the mechanism of CR lepton emission. After calibration, we apply the model to a large actual galaxy sample: CANDELS GOODS-South. Comparing the result to the observational data from Fermi Gamma-ray Space Telescope, COMPTEL and EGRET, We find that SFGs are the major contributor to the IGRB in the energy range of $\sim$1-10 GeV, accounting for 50%-60% of the IGRB. In lower and higher energy range, SFGs still have an impact on IGRB. We also find that emission from CR lepton is comparable to emission from CR proton in lower energy range and even higher than CR proton in the lowest energy band. By analysing the models and results of some previous works, we show the importance of keeping physical assumption consistency.

z=2.3 における大規模ガス加熱を伴う原始銀河団の観測とシミュレーション
(Observations and Simulations on a Galaxy Protocluster with Large-Scale Gas Heating at z=2.3)

35-226367 Chenze Dong

Abstract:
The intergalactic medium (IGM) in the vicinity of galaxy protoclusters is an interesting testbed to study complex baryonic effects such as gravitational shocks and feedback. In this thesis, we report a z=2.30 galaxy protocluster (COSTCO-I) in the COSMOS field, where the Lyman-α forest as seen in the CLAMATO IGM tomography survey does not show significant absorption. This departs from the transmission-density relationship (often dubbed the fluctuating Gunn-Peterson approximation; FGPA) usually expected to hold at this epoch, which would lead one to predict strong Ly α absorption at the overdensity. For comparison, we generate mock Lyman-α forest maps from the constrain simulations of COSMOS field and find a 2.79 σ deviation of COSTCO-I from FGPA. It suggests that the large-scale gas associated with COSTCO-I is being heated above the expectations of FGPA, which might be due to either large-scale AGN jet feedback or early gravitational shock heating. We further utilize hydrodynamical simulations from the SIMBA and The Three Hundred suites to study the mechanisms influencing large-scale Lyman-α transmission in 2<z<2.5 protoclusters. We focus on the matter overdensity-Lyman-α transmission relation ($\delta_m - \delta_F$) on Megaparsec-scales in these protoclusters, which is hypothesized to be sensitive to the feedback implementations. The lower-density regions represented by the SIMBA-100 cosmological volume trace the power-law ($\delta_m - \delta_F$) relationship, as predicted by FGPA. This trend is continued into higher-density regions covered by simulations that implement stellar feedback only. Simulations with AGN thermal and AGN jet feedback, however, exhibit progressively more Lyman-α transmission at fixed matter overdensity. Compared with 7 protoclusters observed in the COSMOS field, only 2 display the excess absorption expected from protoclusters. The others exhibit deviations: 4 show some increased transparency suggested by AGN X-ray thermal feedback models while the highly transparent COSTCO-I protocluster appears to reflect intense jet feedback. Discrepancies with the stellar-feedback-only model suggests processes at play beyond gravitational heating and/or stellar feedback as the cause of the protocluster transparencies. Some form of AGN feedback is likely at play in the observed protoclusters, and possibly long-ranged AGN jets in the case of COSTCO-I. While more detailed and resolved simulations are required to move forward, our findings open new avenues for probing AGN feedback at Cosmic Noon.

A spatially-resolved study of the ISM and obscured star formation in starbursts near cosmic noon

空間分解して探る cosmic noon スターバースト銀河の星間物質およびダストに隠された星形成活動

Zhaoxuan Liu 35-226368

Abstract

Pushing the Atacama Large Millimeter/submillimeter Array (ALMA) to its limits and with the arrival of the James Webb Space Telescope (JWST), we are now able to study structures of galaxies hidden by the dense dust of intense star formation, shedding light on their origins and development. In this dissertation, I present observations and analysis of two starbursts at $z \sim 1.5$ revealed by high-resolution (kpc-scale) ALMA observations and JWST NIRCam/MIRI observations. The molecular line CO (J=5--4) provides gas kinematics for confirming the presence of rotating disks and additional components. At the same time, the FIR continuum gives an assessment of the dust/gas content on scales of $\sim$1-3 kpc. The high-resolution NIRCam data in multiple filters complements the relationships between different components within the starbursts by revealing the spatially resolved stellar distribution and dust attenuation, while MIRI infers the Polycyclic Aromatic Hydrocarbon (PAH) distribution. Exquisite imaging with NIRCam, MIRI, and ALMA reveals diverse structures, including highly obscured starbursting cores, clumps, and even normal spiral features at redder wavelengths. The former indicates the bulge formation, while the latter is challenging whether a major merger is required to trigger a starburst, whereas a minor merger or gas-rich disk instability may be as effective. Regarding the interstellar medium (ISM) gas, all systems exhibit characteristics of being dusty, gas-rich, and centrally concentrated. Within the central region, all exhibit heightened starburst activity, given the associated stellar mass, which is attributed to both high gas fractions and shorter depletion time. Furthermore, the spatially resolved IR8 map discloses a PAH deficit in the central starburst core, likely due to the PAH destruction by the intense star-forming activity. These observations demonstrate the importance of spatially resolved studies on gas and stars for compact distant starbursts.