Blue asymmetries of Balmer lines during M-dwarf flares investigated with multi-wavelength observations

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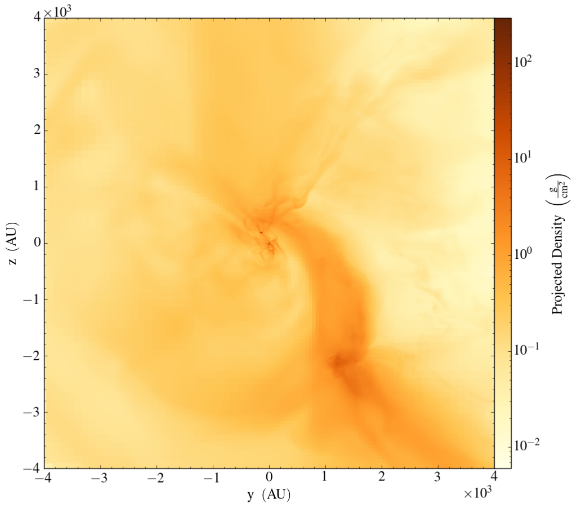

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Flares are magnetic energy release in the solar/stellar atmosphere, and they have strong emissions from radio to X-rays. During some M-dwarf superflares, chromospheric line profiles show blue asymmetries (Honda et al. 2018), though red asymmetries have been seen during many ordinary solar flares. it is also thought that similar enhancements of the blue wing of Balmer lines can provide clues for investigating mass ejections from flares (stellar CMEs) (cf. Vida et al. 2016&2019), but this is still very controversial. Thus, we need more flare spectroscopic observations with high time resolution for understanding how superflares occur and how large mass ejections occur during superflares occur. The latter is helpful for estimating the impacts on planets from superflares. We have conducted several simultaneous spectroscopic and photometric observations of M-dwarf flare stars. In 2019 January, we observed a M-dwarf flare star YZCMi using APO3.5m/ARCES (high-dispersion spectroscopy), APO/ARCSAT0.5m (multi-color photometry), TESS (space high-precision single-color photometry), and NICER (soft X-ray telescope on ISS). During the observation, we detected large enhancements of chromospheric lines lasting for longer than 3 hours (e.g., H- alpha and H-beta). H-alpha line profiles during this event show some blue asymmetries. In this event, we also detected soft X-ray intensity increases, but a bit strangely and a bit different from previous expectations, the photometric data (optical continuum white light data) show no clear flare-like brightness increases. This might suggest that these intensity increases of chromospheric lines (with possible blue asymmetries) and soft X-rays occurred as a ”non white-light” flare events, which are often seen in the case of solar flares (e.g., Watanabe et al. 2017). We also observed another M-dwarf flare star AU Mic using CTIO/SMART1.5m/CHIRON (high-dispersion spectroscopy), LCO (U&V-band photometry), and XMM-Newton (soft X-ray), and detected several flares in Oct 2018. In contrast to the above “non-white light” events, these flares show enhancements in Balmer lines (e.g., H-alpha), optical continuum white light, and soft X-ray. Then this event is a so-called “white-light” flare. Moreover, this “white-light” event does not show clear blue asymmetries,

288.04 — Tentative Gamma-Ray Detection of Fast Rotating TVLM 513-46546

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The Sun is the only main sequence star where gamma-rays have been observed and the flux is particularly large when flares and coronal mass ejections (CMEs) happen. Young ultra cool dwarfs are far more active than the Sun with observed superflares and CMEs which can accelerate charged particles to relativistic velocities. When interacting with the stellar atmosphere, they create neutral pions that decay into gamma-ray photons. We created a phase-folded gamma-ray light curve of TVLM 513-46546 with 8 years of Fermi data and a tentative pulse is detected. We reduce the possibility of a false positive by analyzing a reference source within the same region of interest and two reference fields, and no periodicity signal is detected from any of them. Running the same pipeline on the data with different periods shows that the detection systematically improves towards a specific period. A toy model that can reproduce all the results from the data raises the confidence level of the detection.

288.05 — Blue asymmetries of Balmer lines during M-dwarf flares investigated with multi-wavelength observations

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which are different from the above YZCMi "non-white light" event. In this poster, we introduce ongoing results on the analyses of these two events.

288.06 — Too Young to Say "WTF": Thacher Monitoring of KIC8462852

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We present the entirety of Thacher Observatory photometry of Boyajian's Star (KIC 8462852) from 2017 to 2019 in five photometric bands (V, g',r',i',z'). Our data overlaps with TESS Sectors 14-15, and we use TESS data to validate the timing and magnitude of the low-level variability observed in our dataset and quantify the chromaticity of the variability. An additional goal of our program is to remain at the forefront of variability detection and to help serve as an alarm system for follow-up observations from partner facilities.

Poster Session 289 — Dark Energy & Dark Matter

289.01 — Direct Detection of WIMP Dark Matter with Ultra-Pure Xenon in LUX-ZEPLIN

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Researchers found that visible matter alone is not enough to account for the world we see today. Galaxy formation and gravitational models require an invisible matter called dark matter. Now, the LZ (LUX-ZEPLIN) team is trying to detect WIMPs (Weakly Interacting Massive Particles), one of the leading hypothetical candidates of dark matter. LZ is building a detector that will contain seven tons of ultra-pure liquid xenon which allows us to detect these particles. WIMPs will be detected from the light produced by their occasional collisions with the xenon nuclei. To obtain this ultra-pure xenon, our lab is removing trace radioactive krypton from xenon gas.

289.02 — Characterizing density profiles of dwarf galaxy dark matter halos for cold dark matter and self-interacting dark matter

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The Lambda Cold Dark Matter (ΛCDM) cosmological model successfully explains large-scale structures of the Universe, but it is less successful at predicting smaller structures such as dark matter halos of classical dwarf galaxies ($M_\star \approx 10^{5-7}$ $M_\odot$). Central regions of dwarf galaxies dominated by dark matter are less dense than ΛCDM dark-matter-only simulations predict. This could be an effect of baryonic processes such as supernova feedback, or it could potentially be a result of collisions between particles of self-interacting dark matter (SIDM). We compare the density profiles at $z = 0$ of dark matter halos in CDM simulations to their corresponding SIDM simulations, which introduce a cross-section per unit mass = 1 cm^2/g, for eight simulations with full star formation and feedback physics from the Feedback in Realistic Environments (FIRE) project. Fitting the cored Einasto profile to the simulation data, we find a clear difference between the density profiles of the CDM halos and the less dense, cored density profiles of the SIDM halos. We track the orbital properties of dark matter particles in the CDM and SIDM simulations to investigate the differences between the two types of halo profiles. We acknowledge support from the UT Austin REU grant AST-1757983 (PI: Jogee) funded by the NSF REU and DOD ASSURE programs.

289.03 — A Light in the Dark: UltraLight Dark Matter in Simulation and Observations

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Though the LCDM model has seen a fantastic concurrence of observational data and computational simulations at scales <10 kpc, tensions appear at smaller scales. Simulations predict centrally peaked haloes, and large numbers of both light dark matter haloes and high-luminosity satellite galaxies associated with more massive sub-haloes. At the same time, observations suggest centrally cored haloes, and fail to detect sufficient numbers of the smallest haloes corresponding to dwarf galaxies, or high-luminosity satellite galaxies. These gaps in theory and observation are known as the core-cusp problem, missing satellites problem, and "too big to fail" problem, respectively. Though some of the underlying problems can be softened through baryonic effects, they suggest a deviation from the CDM model on small cosmological scales. One proposed solution to this discrepancy is Ultra Light Dark Matter (ULDM): an axion-like dark matter candidate of mass $\sim 10^{-22}$ eV. The quantum nature of this low-mass axion naturally suppresses structure formation