ABSTRACT
The Experiment for Cryogenic Large-Aperture Intensity Mapping (EXCLAIM) is a high-altitude balloon spectrometer designed to deepen our understanding of star formation in a cosmological context. Rather than identifying individual objects, as in a galaxy redshift survey, EXCLAIM will be a pathfinder to demonstrate an intensity mapping (IM) approach. EXCLAIM will operate at R = 21 – 540 with a spectral resolution of R = 512 to measure the integrated line emission from galaxies and the interstellar medium (ISM). The instrument is ideal for observing CO and CII line emissions from the nearby universe out to redshifts of z = 3.5. CO (and CII) line emissions are key tracers of the gas phases in the interstellar medium involved in star-formation processes. EXCLAIM will shed light on questions such as why the star formation rate declines and breaks away from the cosmological evolution of dark matter or redshifts. EXCLAIM’s instrumental response is comprised of six superconducting integrated grating-photonic detectors (µ-Spec) with superconducting microwave kinetic inductance detectors (MKID) in a cryogenic telescope (1.5 K) to achieve near-background-limited sensitivity. Here, we present an overview of the EXCLAIM instrument and status.

INTENSITY MAPPING (IM)

Rather than detect individual galaxies, EXCLAIM will measure the statistics of brightness fluctuations of redshifted, cumulative line emission. Systematics

Why Intensity Mapping?

• Aperture: Pushing to higher flux sensitivity and lower confusion drives large apertures. Instead, IM measures surface brightness with sensitivity limited by detector noise or photon background.

• Cumulative emission: IM is sensitive to the faintest sources (good–blind complete census) but also all other radiation (bad) – but spectral differences can be used to reject continuum emission.

• Volume: IM provides efficient access to large cosmological volumes and redshifts, reducing cosmic variance.

• Environments: Lines and ionization states track different environments.

• Heats: IM measures the relative clustering of galaxies with bright line emission, which provides insight into the halo masses that host star formation.

• Systematics: No selection function (i.e. no dust extinction or issues such as fiber collisions from nearby galaxies).

EXCLAIM’s Primary Science Questions:

1. What factors led to the dramatic declines in star formation since z = 2 in contrast to dark matter evolution?

2. What is the typical abundance, excitation and evolution of the molecular gas which forms stars?

3. How well does CO trace H2 in galaxies?

4. Is intensity mapping a viable approach to probe high redshifts?

Lines & Levels

CO: EXCLAIM will cross-correlate with spectroscopic galaxy redshift catalogs (black) to constrain the total molecular CO gas abundance from 0 < z < 0.7 and possibly out to z = 3.5 with extended BOSS survey releases.

Cl: EXCLAIM will cross-correlate with the BOSS QSO survey from 2.5 < z < 3.3 to provide a definitive test of CO abundance (shown right) and probe the Cl and the star formation rate (SFR) relation (12). This will allow EXCLAIM’s pointing elevation to be fine-tuned following local relations or suggests strong evolution of the average Interstellar Medium.

Fig. 13: Slab absorption from simulation (black) or real data (red). Slab absorption (red and black) is computed on model (24,32) and preliminary measurements (11). There is no discernible loss of the molecular line and ISL intensity.