

MicroCHaS: Condensing IFU Spectroscopy to an Accessible Scale

Matthew Werneken¹, Jacob Vider², Anna Fedorova³, Alexandra Savino³, David Schiminovich⁴

¹mdw2166@columbia.edu, Department of Mechanical Engineering, Columbia University

²Department of Applied Physics, Columbia University

³Department of Physics and Astronomy, Barnard College

⁴Department of Astronomy, Columbia University

Abstract

MicroCHaS is a high-efficiency, low-cost, compact integral field unit (IFU) spectrograph in development for production on an accessible scale for use by researchers, educators, and in commercial applications. MicroCHaS is a condensed model based on the optical design of the NSF-sponsored Circumgalactic H-Alpha Spectrograph (CHaS), currently in use on the 2.4-meter Hiltner telescope at MDM Observatory in Kitt Peak, AZ. It is currently under development as a commercial and educational instrument for smaller telescopes, and is being explored as a tool for environmentally-rigorous observing environments, such as high-altitude balloon UV observation. MicroCHaS was proposed as the payload for (CU)besat-1, an educational outreach and instrument validation 3U CubeSat under review in the 2023 NASA CubeSat Launch Initiative.

Background and Inspiration

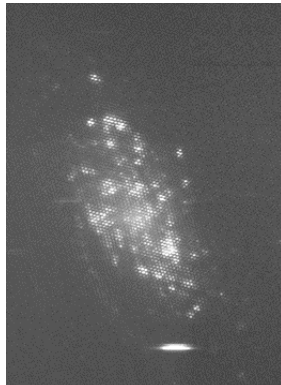
The Circumgalactic H-Alpha Spectrograph (CHaS) was developed by the Schiminovich Astrophysics and Instrumentation Lab at Columbia University. CHaS observes the circumgalactic medium (CGM) near low-redshift ($d < 35$ Mpc) galaxies through a microlens array that divides the field of view into $> 60,000$ spectra for kinematic and compositional analysis. While there exists a higher-resolution tool for mapping the CGM in CHaS, a miniaturized and reproducible IFU spectrograph would be valuable. The Schiminovich Lab has extensive history in

suborbital and orbital UV astronomy, through GALEX and the FIREBall-2 UV balloon telescope.

Applications

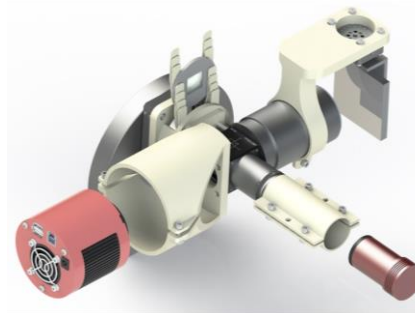
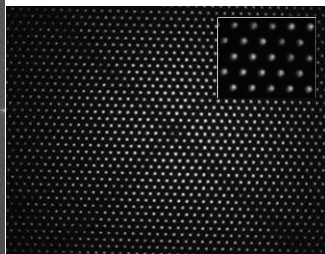
Initial MicroCHaS development has targeted educational applications, wherein the spectrograph mounts to smaller observatories and commercial telescopes. The project targets observation environments where an IFU spectrograph would provide otherwise inaccessible spatially-resolved spectra. This particularly manifests in environments where instrument volume is a limitation, such as suborbital flight.

MicroCHaS serves as the prototype and proof of concept for a parallel IFU spectrograph on (CU)besat-1, a submission to the 2023 NASA CubeSat Launch Initiative as a collaboration between the Columbia Space Initiative, CU Robotics Club, and Schiminovich Lab. This project extension's primary mission is educational outreach, focusing on validating the spectrograph in microgravity and sharing development through an ongoing citizen science program at five underprivileged NYC middle schools. A future goal of MicroCHaS development is a (extremely) high-altitude balloon telescope deployment, challenging balloon-borne telescope altitude records.



Left: NGC 6015 as viewed by CHaS

Right: MicroCHaS laser line field with individual spectra



Left: Initial MicroCHaS optics housing, with additional calibration detector

Top: Sample MicroCHaS footprint in prototype bus (4"x4"x12")