Engimatic Extinction: An Investigation of the 2175Å Extinction Bump in M101

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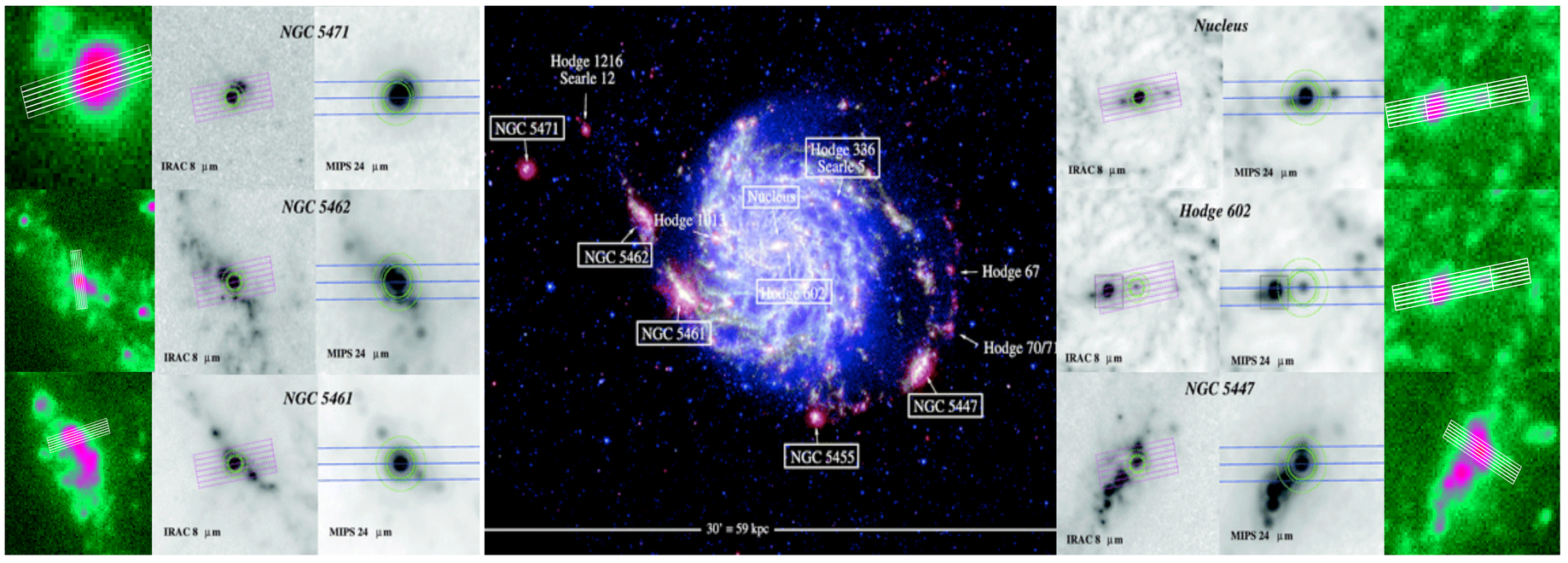
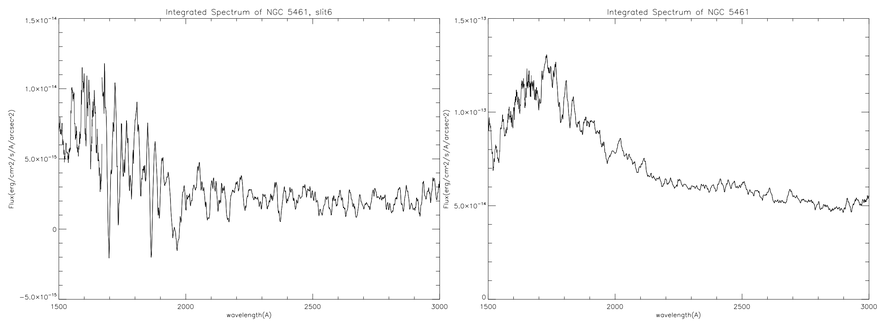
Abstract

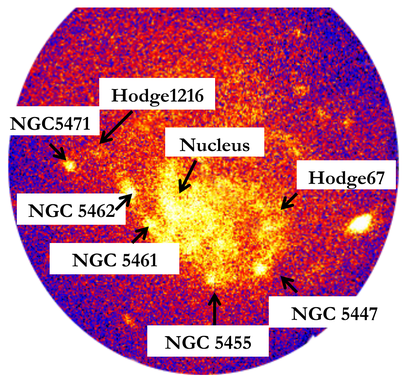
Evidence from studies of starburst galaxies indicates that active formation of high mass stars modifies the UV dust extinction curve as seen by a lack of the characteristic 2175Å bump. For over 45 years, the source of the 2175Å extinction feature has yet to be positively identified. Small aromatic/PAH grains are suggested as a leading contender in dust grain models. The face-on spiral galaxy M101 is an ideal laboratory for the study of dust, with many well-studied HII regions and a steep metallicity and ionization gradient.

The Interstellar Medium Absorption Gradient Experiment Rocket (IMAGER) probes the correlation between dust extinction, and the metallicity and radiation environment in M101 at ultraviolet wavelengths. IMAGER simultaneously images M101 in three 400Å-wide bandpasses, measuring the apparent strength of the 2175Å bump and the UV continuum.

Combining data from IMAGER with high S/N far- and near- UV observations from the MAMA detectors on the Hubble STIS instrument, we examine the apparent strength of the 2175Å bump in HII regions of M101. With additional infrared data from Spitzer, the DIRTY radiative transfer model, and stellar evolution models, we probe the correlation between the 2175Å feature and the aromatic/ PAH features across HII regions of varying metallicity and radiation field hardness. The results of this experiment will directly impact our understanding of the nature of dust and our ability to accurately account for the effects of dust on observations at all redshifts.





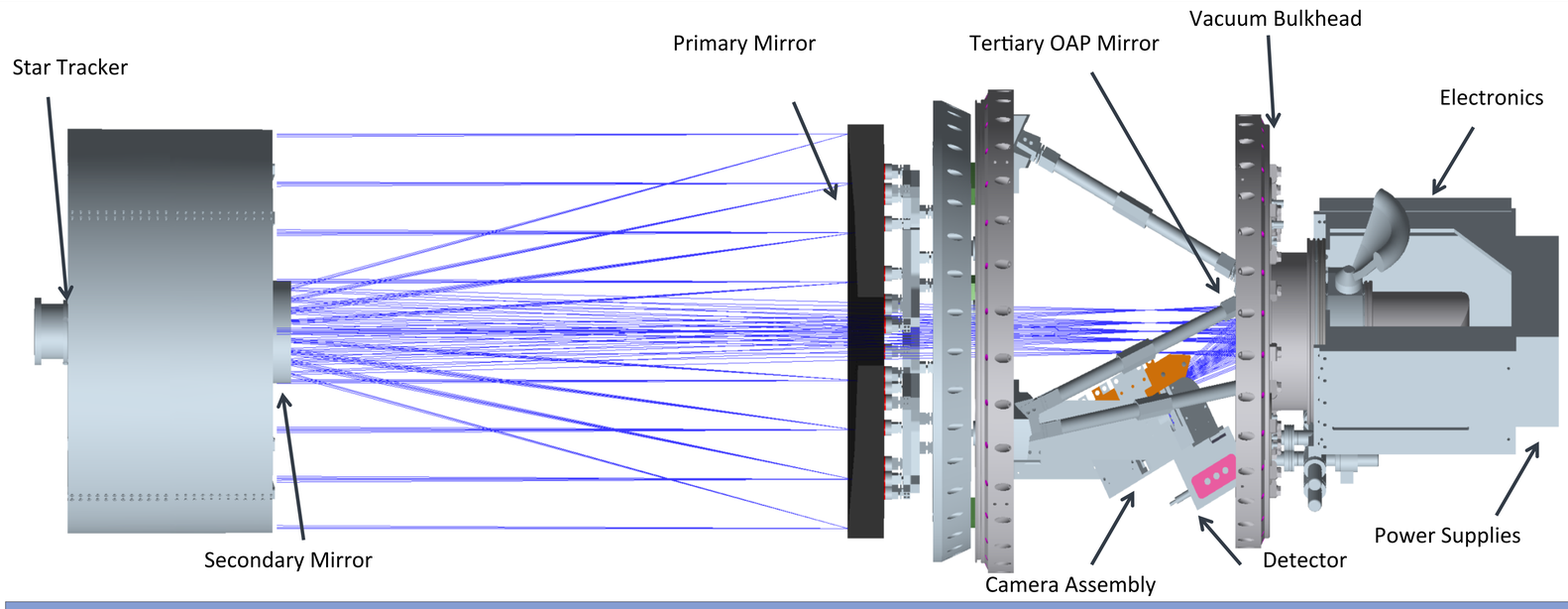


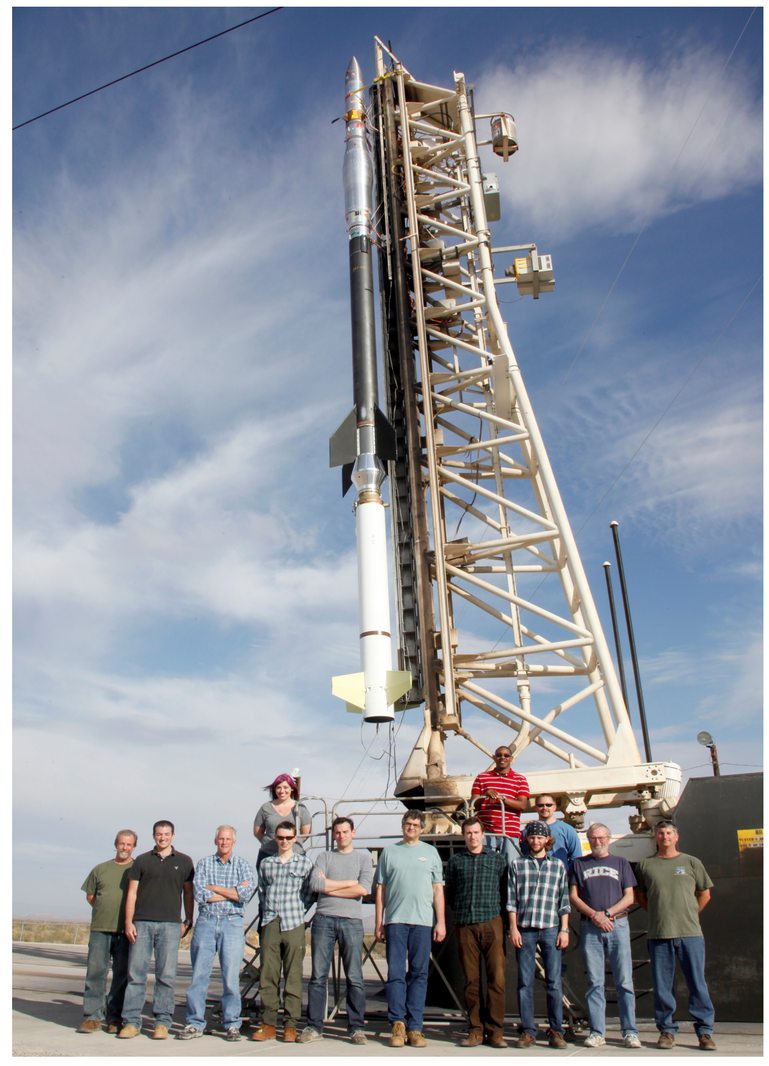
Top: (Center) M101 in Spitzer Infrared from Gordon et al. 07. We collected UV spectra with HST (STIS-MAMA detectors, 52'x2' slit, green images) for 6 regions with available IRS spectra (greyscale)

Far Left& Center: Ultraviolet spectra from HST data for a slit across NGC 5461, and integrated across NGC 5461.

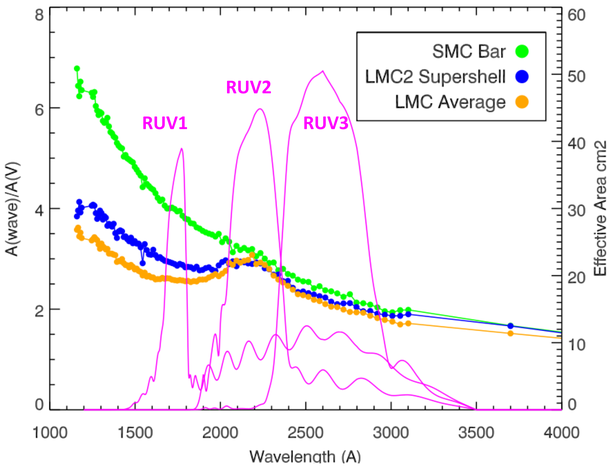
Left: IMAGER combined raw data for M101.

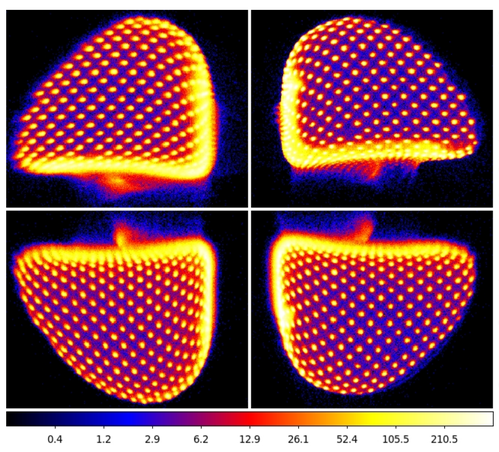
IMAGER Instrument





IMAGER DESIGN	
Telescope	f/12.29 Ritchey-Chretien; $AlMgF_2$ coated for high reflectance in the UV at NASA GSFC
Primary and Secondary	0.5 meter, primary mounted with whiffle tree design ; .12 meter convex secondary, mounted with spring and stainless steel accordion design , with clamping reeds, optimized for alignment ; set polished at Optical Mechanics, Inc.
Tertiary Mirror	.1 meter off axis parabolic mirror from SORL mounted with hexapod structure
Field of View	30 arcminutes, fits M101 with pointing and alignment tolerances
Camera Assembly	Anodized assembly containing four custom beamsplitting dichroics from Acton Optics, 11 lenses in MgF_2, and CaF (9 COTS), and 9 COTS $AlMgF_2$, fold mirrors from CVI Melles Griot and Edmund Optics
Readout Electronics	Refurbished previously flown sounding rocket electronicss to read wedge-and-strip anodes
Detector	40mm microchannel plate detector from Photek Ltd., with CsTe photocathode on a MgF_2 window for high QE in UV. microchannel pores are 3x10 μ m, 10^7 gain, in resistive sea configuration with 4 wedge and strip anodes at detector focal plane, each anode with a square active area of 400mm^2.





Top: Solidworks model and Zemax raytrace of the IMAGER Instrument with component specs.

Far Left: Measured extinction curves from the SMC (no bump) and LMC (large bump) from Gordon et al. 2003. In pink, IMAGER photometric bands/ response curves.

Left: A fine pitch mask imaged onto all four detector anodes to show edge distortions (.018 inch holes on a .05 inch pitch). These images are used in deconvolving the photon data from the instrument.

Acknowledgements

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