GUSTO: the Galactic/Extragalactic Spectroscopic Terahertz Observatory

Goldsmith, P.; Walker, C.; Kulesa, C.; Bernasconi, P.; Tielens, A.G.G.M.; Wolfire, M.; ... ; Kawamura, J.

Bulletin of the AAS • Vol. 54, Issue 6

GUSTO — The Galactic/Extragalactic Spectroscopic Terahertz Observatory

Paul Goldsmith[1] Christopher Walker[2] Craig Kulesa[3]
Pietro Bernasconi[4] Alexander Tielens[5] Mark Wolfire[6] Gary Melnick[7]
David Hollenbach[8] Youngmin Seo[9] Russell Shipman[10]
David Neufeld[11] Christopher Groppi[12] Volker Tolls[7] Erick Young[13]
Antony Stark[14] Harold Yorke[15] Jorge Pineda[9] Jonathan Kawamura[9]

[1]JPL, [2]University of Arizona, [3]Univ. of Arizona, [4]Johns Hopkins Univ., [5]Leiden Observatory, [6]University of Maryland, College Park, [7]Center for Astrophysics | Harvard & Smithsonian, [8]SETI Institute, [9]Jet Propulsion Laboratory, [10]Space Research Organization, [11]Johns Hopkins University, [12]Arizona State University, [13]Universities Space Research Association (USRA), [14]SAO, [15]SOFIA Science Center (retired)

Published on: Jun 29, 2022

URL: https://baas.aas.org/pub/2022n6i333p01

GUSTO (Galactic/Extragalactic Spectroscopic Terahertz Observatory) is a NASA Mission of Opportunity balloon mission currently scheduled to be launched in December 2022 from the Long Duration Balloon (LDB) facility near McMurdo Station, Antarctica. GUSTO will carry out large-area observations of three key fine structure lines – [NII] $^3P_1$-$^3P_0$, [CII] $^2P_{3/2}$-$^2P_{1/2}$, and [OI] $^3P_1$-$^3P_2$, at frequencies 1461.1, 1900.5, and 4744.8 GHz, respectively. A zero pressure balloon will support GUSTO for a baselined 75-day mission. Observing the Southern sky from an altitude of 30-35 km, GUSTO will be above 99.99% of atmospheric water vapor and 99.7% of the dry atmosphere. This allows GUSTO to carry out spectral line observations essentially unhindered by the Earth's atmosphere. Three surveys are planned – a Galactic plane survey (GPS) covering 120^{o2} in the $|l|< 25^o$ region, a Large Magellanic Cloud survey (LMCS) covering 25 sq. deg. in that galaxy, and targeted deep surveys (TDS) of up to eight 1-2 sq. deg. regions. Observations of the three fine structure lines with sub-km/s velocity resolution enables GUSTO to address key questions about the life cycle of the ISM, including the structure of warm neutral regions participating in and affected by star formation (with [CII]), gas ionized by massive stars (with [NII]), and neutral dense photon dominated regions (PDR) powered by massive young stars (with [OI] and [CII]). GUSTO's 90 cm diameter Cassegrain telescope provides FWHM beam widths of 0.9' – 0.6', with the 0.7' beam width at [CII] providing spatial resolution of 2 pc at 10 kpc distance and 10 pc at the 50 kpc distance of the LMC. The telescope is under-illuminated at the highest frequency to yield beamwidth close to those at the lower frequencies. The spectrometer provides velocity resolution better than 1 km/s. 3σ GPS and LMC survey sensitivities are 5-10e-6 erg/s/cm2/sr in ~2 km/s channels at [CII] and [NII], and ~5-10e-5 erg/s/cm2/sr in ~2 km/s at [OI]. The TDS are a factor of 4 more sensitive, with sensitivity sensing column densities corresponding to Av = 0.1 mag. The extensive two-dimensional spectral line images of the Milky Way provided by the GUSTO surveys will form an extensive database of the structure of the ISM's different phases and how they connect to one another. The extensive observations of the LMC will allow investigation of star formation in a low-metallicity environment, and provide a template for the ISM and star formation in dwarf galaxies and low-metallicity distant galaxies. The TDS will permit detection of more extended neutral and ionized gas and probe the relationship between HII regions and PDRs.