Omnarayani Nayak
Curriculum Vitae

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Areas of Expertise

Star Formation: Low-metallicity environments, Milky Way, Magellanic Clouds, super star cluster, modeling young stellar objects, modeling IMF, colliding HI flows
Active Galactic Nuclei (AGN): AGN structure and dynamics, shock-excitation, impact on AGN jets and winds on stellar population
Observing Modes and Data Formats: James Webb Space Telescope MIRI commissioning, JWST MIRI/NIRCam/NIRSpec data processing, echelle spectroscopy data format, IFU spectroscopy data format, radio interferometric data processing and data format, ALMA observation planning (ground-based observatory), HST observation planning (space-based observatory), SOFIA observation planning (space-based observatory), Chandra observation planning (space-based observatory), Lick observation planning (ground-based observatory), Keck observation planning (ground-based observatory), Gemini South Adaptive Optics Imager data processing (ground-based observatory)
JWST Hardware: MRS glints with hardware simulation
Other Observatory Hardware: Optimize ALMA 7m and 12m array configuration

Professional Positions Held

US Naval Observatory
Astronomer | Tool Developer
February 2026 –

NASA Goddard Space Flight Center
NASA Postdoctoral Program Prize Fellow
May 2023 – February 2026

Space Telescope Science Institute
Postdoctoral Research Associate
January 2023 – April 2023

Space Telescope Science Institute
STScI Postdoctoral Prize Fellow
June 2019 – December 2022

Johns Hopkins University
Postdoctoral Research Associate
June 2018 – May 2019

Education

Johns Hopkins University, Baltimore, MD
Doctor of Philosophy in Physics, May 2018
Dissertation Adviser: Dr. Margaret Meixner

Johns Hopkins University, Baltimore, MD
Masters of Arts in Physics, May 2014

University of California Berkeley, Berkeley, CA
Bachelor of Arts in Physics and Astrophysics, May 2012

Teaching and Mentorship Experience

January 2021 – February 2026
Mentored graduate student Nally and postdocs Hirschauer, Lenkíc, and Habel on JWST pipeline tools and reduction methods
My collaborative efforts led to four first-author papers with some of the first JWST science data taken as early as September 2021

Summer 2024
Mentored six high school and undergraduate students for 12 weeks for their summer research by fostering a culture of engagement, diversity, inclusiveness, excellence and innovation
One student will be presenting their final poster at the 245th AAS meeting

Spring 2014
Introduction to Thermal Physics for Undergraduates
Radiative Astrophysics for Graduate Students

Fall 2013
Introduction to Thermal Physics for Undergraduates
General Physics Laboratory for Undergraduates

Fall 2012
Introduction to Mechanics for Undergraduates
General Physics Laboratory for Undergraduates

Awards and Leadership Roles

AURA Achievement Award for the Data Visualization and Science Workflow Notebook Team
AURA Achievement Award for the JWST Data Management Working Group
AURA Outstanding Achievement Award for JWST Cycle 1
JWST GTO program #1235 science lead for calibrating, testing, and publishing data
MIRI team ReDCaT lead for delivering reference files before and during commissioning for JWST

Service and Professional Activities

HST Cycle 33 TAC Panel Reviewer	2025
HST Cycle 32 TAC Panel Reviewer	2024
JWST Cycle 4 TAC Panel Reviewer	2024
ALMA Cycle 11 Panel Reviewer	2024
ALMA Cycle 10 Panel Reviewer	2023
Astrophysics Journal Referee	2022
STScI Weekly Star Formation Journal Club	2012 - 2019
STScI Weekly Local Group and Galaxy Evolution Journal Club	2012 - 2019
Johns Hopkins Physics Department Annual Open House	2016
Johns Hopkins Physics Department Annual Open House	2015
Johns Hopkins Physics Department Annual Open House	2014
UC Berkeley Undergraduate Search Committee	2012

Major Contributions to Commissioning the James Webb Space Telescope in Order to Maximize Scientific Performance, Efficiency, and Longevity with Real and Simulated Data Sets

Title: LRS Cross Calibration Check
Objective: Compare LRS simulated data and real data of standard stars to MRS, Imager, and Coronographic simulated data to make sure flux measurements and wavelength centers are consistent between all the four modes of MIRI.

Title: MRS Glints
Objective: Simulate Jupiter and Saturn to check if MIRI PSF has prominent peaks due to scattered light of large planets.

Title: LRS External Flatfield
Objective: Determine the external flat fields necessary during commissioning.

Title: LRS Absolute Flux Calibration
Objective: Build a spectrophotometric calibration for LRS by observing JWST flux standards (A dwarfs and Solar analogs) through the LRS slit and slitless modes.

Title: LRS PSF Characterization
Objective: Characterize the PSF as a function of wavelength in the LRS slit and slitless modes by scanning a point source across the two nod positions, the center of the slit, and across the nominal position in slitless mode. This will lead improved algorithms for extracting spectra from 2D spectral images.

Title: MRS Flux Conservation
Objective: Calculate the flux of a simulated source to see if the flux is being conserved in the 12 different MRS IFU bands. I investigated potential issues and worked with the pipeline team to push new version with fixes.

Title: MRS Outlier Detection
Objective: Determine if the pipeline is catching all outliers by inputting fake outliers with varying fluxes and at various wavelengths.

Title: MIRI IFU of Young Stellar Objects in the Large Magellanic Cloud
Objective: The objective of the notebook I created was to simulate working with an IFU cube, extracting point sources, and analyzing the infrared spectra of the point sources. I used ALMA data cubes and Spitzer IRS spectroscopy to showcase how we will process and analyze the MIRI MRS data. My notebook was successfully presented to project managers and mission office at Goddard in January 2021.

JWST GTO AND Cycle 1 Proposals

Title: "Exploration of the Nuclear Jet Impact on the ISM in Seyfert Galaxy NGC 4258"
Instrument: NIRCam, large strategic mission
P.I.: **J. Glenn**
CoI(s): **O. Nayak**, T. Fischer, E. Smith, H. Schmitt

Title: "LMC-N79: Study of Most Massive Young Stellar Object Star Forming Region"
Instrument: MIRI Imaging, NIRCam Imaging, MIRI MRS, large strategic mission
P.I.: **M. Meixner**
Science Lead: **O. Nayak**

Title: "NGC346: Star Formation at Low Metallicity in the Large Magellanic Cloud"
Instrument: MIRI Imaging, NIRCam Imaging, MIRI MRS, NIRSpec, large strategic mission
P.I.: **M. Meixner**
CoI(s): **O. Nayak**, A. Hirschauer, O. Jones, et al.

Title: "Supernova 1987A: Formation and Evolution of Dust in Supernova Explosion"
Instrument: MIRI Imaging, NIRCam Imaging, MIRI MRS, NIRSpec, large strategic mission
P.I.: **M. Meixner**
CoI(s): **O. Nayak**, A. Hirschauer, O. Jones, et al.

Title: "NGC 6822: Dust Life Cycle of a Nearby Low Metallicity Galaxy"
Instrument: MIRI Imaging, NIRCam Imaging, large strategic mission
P.I.: **M. Meixner**
CoI(s): **O. Nayak**, A. Hirschauer, O. Jones, et al.

Title: "1 Zwicky 18: Dust Life Cycle at Very Low Metallicities"
Instrument: MIRI Imaging, NIRCam Imaging, large strategic mission
P.I.: **M. Meixner**
CoI(s): **O. Nayak**, A. Hirschauer, O. Jones, et al.

Successful Observing Proposals from Other Large Strategic Missions and Observatories

Title: "Studying Gas Heating Mechanisms of a Super Star Cluster with SOFIA"
Instrument: SOFIA, large strategic mission
P.I.: **O. Nayak**
CoI(s): M. Y. Lee, Y. Okada, M. Chevance, A. Hirschauer, H. Zinnecker, M. Andersen
Grant: $12,300

Title: "N79: The Once and Future 30 Doradus"
Instrument: ALMA, large strategic mission
P.I.: **O. Nayak**
CoI(s): M. Meixner, B. Ochsendorf, C. Battersby, A. Rosen, H. Zinnecker
Grant: *NA*

*Title: "*A Superstar Cluster is Born: Probing the X-ray Emission of H72.97-69.39 in LMC-N79"
Instrument: Chandra, large strategic mission
P.I.: L. Lopez
CoI(s): **O. Nayak**, A. Rosen, G. Olivier
Grant: $68,000

Title: "A Spectroscopic Study of Young Candidate Intermediate-Mass Protostars in the Magellanic Clouds"
Instrument: Magellan FIRE Spectrometer, ground-based observations
P.I.: M. Reiter
CoI(s): **O. Nayak**, M. Meixner
Grant: *NA*

Title: "Measuring the Outflows from Massive Young Stellar Objects in the Large Magellanic Cloud"
Instrument: SOFIA, large strategic mission
P.I.: M. Meixner
CoI(s): **O. Nayak**, M. Y. Lee, M. Chevance, Y. Okada, J. Stutzki, Y. Fukui, T. Onishi
Grant: $60,000

Press Release and Publicity for First-Author Peer-Reviewed Publications

BBC's The Sky at Night Season 28: My work on super star cluster H72.97-69.39 will be featured in one of BBC's longest running television program The Sky at Night in Spring/Summer 2025.

"Astronomers are Watching a Newly Forming Super Star Cluster," Universe Today news statement on my discovery of super star cluster H72.97-69.39.
Link: https://www.universetoday.com/170468/astronomers-are-watching-a-newly-forming-super-star-cluster/

"Galactic Genesis: Webb Space Telescope Reveals Massive Star Forming Complex," SciTech Daily news statement of super star cluster H72.97-69.39.
Link: https://scitechdaily.com/galactic-genesis-webb-space-telescope-reveals-massive-star-forming-complex/

"Young Stars in the Milky Way's Backyard Challenge Our Understanding of How They Form," 245th AAS meeting press release of super star cluster H72.97-69.39. JWST NIRCam observations reveal without a doubt that the N79 region of the LMC is host to a super star cluster. There are over 1500 protostars in the vicinity of this super star cluster which is less than 100,000 years old as revealed by ALMA.
Link: https://public.nrao.edu/news/young-stars/

"A Massive Cluster is Born," ESA/Webb picture of the month for January 2024 of super star cluster candidate H72.97-69.39 located in the Large Magellanic Cloud. With this four-color image made with MIRI filters we can see where the star formation is taking place with yellow and red colors, and how the star formation is destroying its parental cloud in blue and cyan.
Link: https://esawebb.org/images/potm2401a/

Press Release and Publicity for Other Peer-Reviewed Publications

"Webb finds Planet-Forming Disks Lived Longer in Early Universe," JWST NIRCam observations of NGC 346, a low-metallicity environment similar to the early Universe, is host to planet forming disks that live longer than current model predictions.
Link: https://esawebb.org/news/weic2430/

"Hidden Intricacies of Messier 106," ESA/Webb picture of the month for August 2024. Messier 106, or NGC 4258, in a nearby galaxy with an active galactic nucleus. In addition to the regular spiral arms, this galaxy has two anomalous arms offset from the spiral arms, and previously seen with radio and X-ray wavelengths. JWST NIRCam observations reveal [FeII] and H_2 in these anomalous arms.
Link: https://esawebb.org/images/potm2407a/

"A Duo of Starburts in I Zwicky 18," ESA/Webb picture of the month for March 2024. I Zwicky 18 has one of the lowest metallicity of all known galaxies in the Local Universe. Paradoxically, this galaxy could be up to 10 billion years old and has undergone several bursts of star formation in the past and therefore should have a higher metallicity content. JWST NIRCam and MIRI observations reveal two different stellar populations within I Zwicky 18.
Link: https://esawebb.org/images/potm2403a/

"Webb Find Evidence of Neutron Star at Heart of Young Supernova Remnant," Supernova 1987a, located in the Large Magellanic Cloud, has spectra taken with both the JWST MRS and NIRSpec modes. MRS observations indicated ionized Argon, and subsequent NIRSpec observations shows [Ar V]. Photons necessary for such ionized Argon emission can only be from a newly formed neutron star or magnetar (a neutron star with a strong magnetic field).
Link: https://webbtelescope.org/contents/news-releases/2024/news-2024-112

"The Life and Times of Dust," ESA/Webb picture of the month for July 2023 of galaxy NGC 6822. The NIRCam imaging shows the stellar population while the MIRI imaging reveals the dusty regions.
Link: https://esawebb.org/images/potm2307a/

"NASA's Webb Uncovers Star Formation in Cluster's Dusty Ribbons," press release about solar-mass star formation in the low-metallicity environment NGC 346 located within the Small Magellanic Cloud. We are seeing conditions of possible planet formation in low-metallicity environments, indicating planet-formation could have taken place in similar low-metallicity conditions around cosmic noon.
Link: https://www.nasa.gov/feature/goddard/2023/nasa-s-webb-uncovers-star-formation-in-cluster-s-dusty-ribbons

Invited Speaker for Colloquia and Seminars

July 2022 — Young Stellar Objects in CO Molecular Clouds in 30 Doradus
Star Formation in 30 Doradus Seminar (San Jose, California)

April 2022 — Extreme Star Formation in the Large Magellanic Cloud
San Jose State University Monthly Physics Colloquia (San Jose, California)

September 2021 — Multi-Wavelength Analysis of a Super Star Cluster
NASA Ames Weekly Colloquia (San Jose, California)

Conferences, Seminars, Public Talks, Press Events, and Other Oral Communications

May 2025 — JWST Photometry and Spectral Reveal Dust and Ice in the Magellanic Clouds
STScI Spring Colloquia (Baltimore, MD)

March 2025 — JWST Photometry and Spectra Reveal Dust and Ice in Super Star Cluster in N79
NASA Goddard SED Director's Seminar Series (Greenbelt, MD)

January 2024 — A Super Star Cluster in Born – JWST NIRCam Observations of H72.97-6.39
Press Conference at the American Astronomical Society Conference (Washington, D.C.)

January 2024 — JWST Reveal Dust and Ice in Super Star Cluster H72.97-69.39
O. Nayak, M. Meixner, C. Nally et al, 2025, AAS, 142.04
American Astronomical Society Conference (Washington, D.C.)

April 2024 — NGC 4258 – Star Formation Occurring in an Anomalous Active Galactic Nuclei
Recipes to Regulate Star Formation at All Scales Conference (Baltimore, Maryland)

August 2019 — Multi-Wavelength Analysis of a Super Star Cluster with ALMA and SOFIA
Space Telescope Science Institute Summer HotSci Colloquia (Baltimore, Maryland)

June 2019 — Multi-Wavelength Analysis of a Super Star Cluster
Linking the Milky Way and Nearby Galaxies Conference (Helsinki, Finland)

January 2019 — Massive Stars and Super Star Clusters
UMass Amherst Local Galaxies Talk Series Seminar (Amherst, MA)

January 2019 — SSC Candidate in the Large Magellanic Cloud
Harvard Galaxies & Cosmology Talk Series Seminar (Cambridge, MA)

November 2018 — ALMA in the Era of JWST
NRAO Weekly TUNA Talk Series Seminar (Charlottesville, VA)

October 2018 — Massive Star Formation – Using ALMA To Prepare for JWST
Princeton University Star Formation/ISM Seminar (Princeton, NJ)

October 2018 — Massive Star Formation
NASA Goddard Weekly Star Formation Colloquia (Greenbelt, MD)

October 2018	Extreme Star Forming Environments in the Large Magellanic Cloud University of Maryland Astronomy Department Seminar (College Park, MD)
August 2018	Sites of Massive Star Formation in the Large Magellanic Cloud Johns Hopkins Exoplanet, Star, and Planet Formation Colloquia (Baltimore, MD)
February 2018	Extreme Star Formation in the Large Magellanic Cloud NASA Ames Weekly Colloquia (San Jose, California)
January 2018	Analysis of Extreme Star Formation Environments in the LMC Nayak, O., 2018, AAS, 231, 313.02 American Astronomical Society Conference (Washington, D.C.)
August 2017	The Most Luminous YSO in the LMC Star Formation in Different Environment Conference (Quy Nhon, Vietnam)
October 2016	Multi-Wavelength Analysis of the Most Luminous Young Stellar Object in the LMC Star-Formation and Feedback in the SOFIA Era Conference (Asilomar, California)
June 2016	Relation Between Massive Star Formation and the Structure of CO Clumps in the LMC Space Telescope Science Institute Summer HotSci Colloquia (Baltimore, Maryland)
January 2016	30 Doradus – Relating Young Stars to the CO Molecular Gas Observed with ALMA O. Nayak, M. Meixner, R. Indebetouw, et al. 2016, AAS, 227, 205.01 American Astronomical Society Conference (Orlando, Florida)
March 2015	ALMA Observations of the Large Magellanic Cloud Soul of High Mass Star Formation Conference (Puerto Varas, Chile)
April 2013	Modeling of Emission of Quasar Winds Pennsylvania State University Local Group Conference (College Park, Pennsylvania)
February 2012	Geometry of Spinor Condensates with Large Spins O. Nayak, A. Turner, 2012, APS, P4.002 American Physics Society Conference (Boston, Massachusetts)

Posters Presentations for Conferences

May 2025	JWST Peers Into the Heart of a Super Star Cluster in the Large Magellanic Cloud XMC Clouds Over Bozeman (Bozeman, Montana)
December 2022	JWST Reveals for the First Time Low-Mass Young Stellar Object in NGC 346 JWST First Science Results Conference (Baltimore, Maryland)
August 2016	Relating Young Stellar Object to Molecular Clouds Observed with ALMA Star Formation Conference (Exeter, England)
October 2015	Analyzing the Relation Between Young Stellar Objects and Molecular Clouds in 30 Doradus Feedback in the Magellanic Clouds Conference (Baltimore, Maryland)

July 2015 — The Structure and Mass of Molecular Cloud N159 in the LMC Using Dendrograms
30 Years of Photodisassociated Regions Conference (Asilomar, California)

Community Outreach and Public Engagement Activities

STScI STEM Learning and Public Outreach (2019 - 2023)

Engaging all ages to be curious about the Universe. Showcasing the highlights of Hubble and ALMA, as well as broadening the public's understanding of JWST science capabilities. I championed NASA's commitment to diversity, equity, inclusion, and accessibility by volunteering to teach STEM to K-12 students in Baltimore.

Johns Hopkins Physics and Astronomy Graduate Students Outreach (2012 - 2019)

Volunteer to help local K-12 students in Baltimore get interested in astronomy. Help build a portable planetarium and work on planetarium shows for the public. Develop lesson astronomy and physics lesson plans with teachers to promote STEM career tracks.

UC Berkeley Compass Project (2008 - 2012)

Help coordinate talks and social events with the UC Berkeley physics department to promote interest in the physical sciences within the undergraduate community.