



Murdock Hart

Education

- 2011–2018 **Ph.D. Physics**, *Johns Hopkins University*, Baltimore.
Dissertation title: "Enabling Fainter Astronomical Observations Through Instrumentation and Data Analysis"
Committee: Stephan McCandliss (Chair), Tobias Marriage, Francesca Serra, Laurent Pueyo, James E. Gunn
- 2005–2011 **B.S. Physics**, *Arizona State University*, Tempe, 4.0 GPA.
Minor in Astronomy
- 2005–2011 **B.S. Mathematics**, *Arizona State University*, Tempe, 4.0 GPA.
Graduated Summa Cum Laude May 2011
- 2001–2003 **Certificate CNC Programming**, *Mid-Florida Technical Center*, Orlando.
- 1990–1992 **Welding Certification AWS 7018 3G, 4G**, *Brevard Community College*, Cocoa.

Experience

- 2019– **Senior Research Scientist**, *Boston University Department of Astronomy*, Boston.
I am currently the observatory manager for the Perkins Telescope Observatory, in this role I specifically
- Maintain observatory astronomical instrumentation
 - Install observatory astronomical instruments
 - Maintain and improve observatory software
 - Repair and improve observatory mechanical infrastructure
 - Astronomical observations using optical and near-infrared instruments including imaging, spectroscopy, and polarimetry
 - Train new observers
 - Observe targets of opportunity for observatory users
 - Implemented additive manufacturing for the construction of observatory items

441 W Wulfenite Rd – Flagstaff, AZ 86005

📞 1 (410) 961 0916 • ✉ murdock@bu.edu •  [MurdockHart](#)

2018-2019 **Assistant Research Scientist**, *Johns Hopkins University Department of Physics and Astronomy*, Baltimore.

I managed the final design and construction of the visible / near-infrared cameras for the Prime Focus Spectrograph (PFS), in this role I specifically

- Designed electro/mechanical/optical systems
- Implemented safe electrical and optical assembly procedures
- Performed thermal modeling of cryogenic systems
- Automated testing and data analysis using python code
- Implemented single board computers (SBC) for automation and testing
- Coordinated and oversaw manufacturing of precision components using traditional manufacturing processes
- Implemented advanced metrology techniques for the alignment of optical components
- Characterization of quantum efficiency (QE), linearity, cosmetics, and read noise performance for scientific photo-sensitive devices including charge coupled devices (CCDs) and complimentary metal oxide semiconductor (CMOS) technologies
- Implemented 3D printing technologies including FDM, SLA, and CLIP to enable the construction of scientific instruments

2012-2018 **Graduate Research Assistant**, *Johns Hopkins University Department of Physics and Astronomy*, Baltimore.

My graduate studies and research were in the areas of astronomical instrumentation, with a focus on scientific charge coupled devices (CCDs), and sky subtraction algorithms to improve ground based astronomical data quality

Detailed achievements:

- Responsibilities included design and construction of infrastructure to safely assemble, test, and optimize the photosensitive detectors for the Prime Focus Spectrograph (PFS) including:
 - Designed and built cryogenic UHV chamber for detector operation (a);
 - Designed and built non-contact metrology system to measure cryogenic surface topography of large format scientific CCDs (b);
 - Assembly and alignment of focal plane arrays (c);
 - Designed and 3D printed relative reflectometer for reflectance measurements of back side illuminated CCDs (d);
 - Automated the control of systems and data acquisition using python (e);
 - Built calibrated illumination system to characterize CCD performance (f);
 - Analyzed raw CCD images for performance characterization using python (g);
- Analysis of atmospheric airglow emission captured in a large astronomical data set:
 - Characterized temporal and spatial variations of atmospheric airglow emissions (a);
 - Coupled coincident satellite observations to gain further insights into spatial characteristics (b);
- Implemented additive manufacturing for the rapid prototyping and construction of scientific instruments using FDM and SLA processes
- Coordinate measurement machine (CMM) dimensional metrology of instrument mechanical and optical components using DMIS and I++ programming


2011-2012 **Graduate Research Assistant**, *Johns Hopkins University Department of Physics and Astronomy*, Baltimore.

Responsibilities included the design of ground calibration equipment for the ACCESS project

2010-2011 **Research Assistant**, *Arizona State University School of Earth and Space Exploration*, Tempe.

Responsibilities included refurbishment of a 21 cm radio telescope

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- 2008–2010 **Research Assistant**, *Arizona State University Physics Department, CIMD Research Group*, Tempe.
Responsibilities include conducting experiments, experiment design, data acquisition, and general maintenance
- 2009–2010 **Grader**, *Arizona State University Department of Physics*, Tempe.
Responsibilities include grading assignments and exams from quantum I and II
- 2005–2008 **Machinist**, *S&S Machine*, Mesa.
Responsibilities include machining, welding, maintenance of equipment, customer service and light accounting duties
- 2004–2005 **Machinist**, *KRC Performance*, Cocoa.
Explored new modifications to develop more horsepower and options for engine-building program
- 1995–2004 **Machinist/Manager**, *Hart Auto Machine*, Titusville.
Managed performance engine rebuilding machine shop

Awards

- John and Richard Jacob Award for Undergraduate Research (2010)
Arizona State University, Department of Physics
- Goldwater Scholar (2009)
United States Congress
- John C. Wheatley Undergraduate Research Scholarship (2009)
Arizona State University, Department of Physics
- Vesto M. Slipher Outstanding Student Scholarship (2008)
Arizona State University, Department of Physics
- Vesto M. Slipher Outstanding Student Scholarship (2007)
Arizona State University, Department of Physics

Computer Skills

- OS: MacOSX, Windows, Ubuntu
- Software: Microsoft Office, Creo, ProE, Solidworks, Simplify3D, LaTeX
- Languages: Python, C++, Java, IDL, DMIS, openDMIS, I++, G-code, LabVIEW
- Hardware: Mac, PC, RaspberryPi, LabJack

Professional Affiliations

- SPIE Society of Photo Optical Instrumentation Engineers Student Affiliate
- AAS American Astronomical Society Student Affiliate
- SPS Society of Physics Students Affiliate

First Author Publications

- [1] Hart, M. (2019). A Comparison of Einstein A Coefficients for OH Rotational Temperature Measurements Using a Large Astronomical Data Set. *Atmosphere*.
<https://doi.org/10.3390/atmos10100569>

- [2] Hart, M. (2019). Sky Residual Correction. *The Astronomical Journal*. <https://doi.org/10.3847/1538-3881/ab1a35>
- [3] Hart, M., Barkhouser, R. H., Gunn, J. E., and Smee, S. A. (2018). Focal Plane Array Alignment and Cryogenic Surface Topography Measurements for the Prime Focus Spectrograph. Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <https://doi.org/10.1117/12.2312225>
- [4] Hart, M. (2018). Long Term Spectroscopic Observations of the Atmospheric Airglow by the Sloan Digital Sky Survey. *Publications of the Astronomical Society of the Pacific*. <https://doi.org/10.1088/1538-3873/aae972>
- [5] Hart, M., Barkhouser, R. H., Gunn, J. E., and Smee, S. A. (2016). A Novel Reflectometer for Relative Reflectance Measurements of CCDs. In A. D. Holland and J. Beletic (Eds.), (Vol. 9915, pp. 99152D–6). Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <http://doi.org/10.1117/12.2232943>
- [6] Hart, M., Barkhouser, R. H., Carr, M., Golebiowski, M., Gunn, J. E., Hope, S. C., and Smee, S. A. (2014). Focal Plane Alignment and Detector Characterization for the Subaru Prime Focus Spectrograph. In A. D. Holland and J. Beletic (Eds.), (Vol. 9154, pp. 91540V–16). Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <http://doi.org/10.1117/12.2057558>

Co-Authored Publications

- [7] Smee, S. A., Gunn, J. E., Golebiowski, M., Hope, S. C., Madec, F., Gabriel, J.-F., et al. (2016). Visible Camera Cryostat Design and Performance for the SuMIRe Prime Focus Spectrograph (PFS). In C. J. Evans, L. Simard, and H. Takami (Eds.), (Vol. 9908, pp. 99088Y–17). Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <http://doi.org/10.1117/12.2233185>
- [8] Tamura, N., Takato, N., Shimono, A., Moritani, Y., Yabe, K., Ishizuka, Y., et al. (2016). Prime Focus Spectrograph (PFS) for the Subaru Telescope: Overview, Recent Progress, and Future Perspectives. In C. J. Evans, L. Simard, and H. Takami (Eds.), (Vol. 9908, pp. 99081M–17). Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <http://doi.org/10.1117/12.2232103>
- [9] Gunn, J. E., Fitzgerald, R., Hart, M., Hope, S. C., Loomis, C., Peacock, G. O., et al. (2016). Detector and Control System Design and Performance for the SuMIRe Prime Focus Spectrograph (PFS) Cameras. In C. J. Evans, L. Simard, and H. Takami (Eds.), (Vol. 9908, pp. 990893–13). Presented at the SPIE Astronomical Telescopes + Instrumentation, SPIE. <http://doi.org/10.1117/12.2233400>
- [10] Q. Xing, M. A. Hart, R. J. Culbertson, J. D. Bradley, N. Herbots, B. J. Wilkens, D. A. Sell, and C. F. Watson, “Particle-Induced X-ray Emission (PIXE) of Silicate Coatings on High Impact Resistance Polycarbonates”, 21st International CAARI 2010 Proceedings, AIP Conference Proceedings, Aug 2010
- [11] Q. Xing, N. Herbots, M. Hart, J. D. Bradley, B. J. Wilkens, D. A. Sell, C. H. Sell, H. M. Kwong, Jr., R. J. Culbertson, and S. D. Whaley, “Ion Beam Analysis of Silicon-Based Surfaces and Correlation with Surface Energy Measurements”, 21st International CAARI 2010 Proceedings, AIP Conference Proceedings, Aug 2010

- [12] N. Herbots, Q. Xing, M. Hart, J. D. Bradley, D. A. Sell, R. J. Culbertson, and B. J. Wilkens, "IBMM of OH Adsorbates and Interphases on Si-Based Materials", 17th International Conference on IBMM, to be published in IBMM 2010 Proceeds in Nuclear Instruments and Methods of Physics: B.

Patents

Molecular Films for Controlling Hydrophobic, Hydrophilic, Optical, Condensation and Geometric Properties of Silicone Implants Surfaces, Including Intra-Ocular Lenses Used in Cataract Surgeries.

Inventor(s): N. Herbots, J. D. Bradley, M. Hart, D. A. Sell and S. D. Whaley
Arizona State University/Arizona Technology Enterprise Provisional patent application filed October 2009.

Methods for Wafer Bonding and for Nucleating Bonding Nanophases

Inventor(s): N. Herbots, J. D. Bradley, M. Hart, D. A. Sell, J. M. Shaw, R.J Culbertson

Provisional Patent Application SN 61/174,138 , Arizona State University/Arizona Technology Enterprise filed March 30, 2009.

Technology Disclosures

Molecular Films for Hydrophobic Implant Surfaces

Inventor(s): N. Herbots, J. D. Bradley, M. Hart, D. A. Sell, S. D. Whaley and Q. Xing

Arizona State University/Arizona Technology Enterprise, AzTE 09-971-PCT, filed October 28, 2010

Methods for Wafer Bonding, and for Nucleating Bonding Nanophases

Inventor(s): N. Herbots, J. D. Bradley, M. Hart, D. A. Sell and S. D. Whaley
Arizona State University/Arizona Technology Enterprise, AzTE 08-1316-PCT, filed August 16, 2010

Molecular Films for Controlling Hydrophobic, Hydrophilic, Optical, Condensation and Geometric Properties of Silicone Implants Surfaces, Including Intra-Ocular Lenses Used in Cataract Surgeries

Inventor(s): N. Herbots, R.J Culbertson, J. D. Bradley, M. Hart, D. A. Sell and S. D. Whaley

Arizona State University/Arizona Technology Enterprise, AzTE M10-028P, filed September 4, 2009

Low Temperature (25°- 200°C) Wafer Bonding via a Cross-Bonding Nanointerphase (SILOXSI) for Biomedical and Device Application, Including an EpOxNox Processing Tools

Inventor(s): N. Herbots, J. D. Bradley, M. Hart, D. A. Sell, J. M. Shaw, R.J Culbertson

Arizona State University/Arizona Technology Enterprise, AzTE M9-035P (MBHB 08-1316), filed October 1, 2008.