

PROCEEDINGS OF SPIE

# ***Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave***

**Makenzie Lystrup  
Marshall D. Perrin**  
*Editors*

**14–22 December 2020  
Online Only, United States**

*Sponsored and Published by  
SPIE*

**Volume 11443**  
Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 11443

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at [SPIDigitalLibrary.org](http://SPIDigitalLibrary.org).

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Space Telescopes and Instrumentation 2020: Optical, Infrared, and Millimeter Wave*, edited by Makenzie Lystrup, Marshall D. Perrin, Proceedings of SPIE Vol. 11443 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9781510636736

ISBN: 9781510636743 (electronic)

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

[SPIE.org](http://SPIE.org)

Copyright © 2020, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$21.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/20/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL LIBRARY**

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

# Contents

## Part One

---

### OPERATIONAL & PAST MISSIONS

---

- 11443 08 **The role of NASA Engineering and Safety Center (NESC) in advancing NASA's astrophysics missions (past, present, and future)** [11443-270]
- 11443 09 **The *Herschel* Space Observatory development, operation and post-operations: lessons learned** [11443-1]

---

### WIDE FIELD SURVEY MISSIONS I

---

- 11443 0F **Euclid mission status after mission critical design** [11443-7]
- 11443 0G **Status of the performance of the Euclid spacecraft** [11443-8]

---

### WIDE FIELD SURVEY MISSIONS II

---

- 11443 0I **SPHEREx: NASA's near-infrared spectrophotometric all-sky survey** [11443-10]
- 11443 0J **A space-based near-infrared sky survey to study the oxygen abundance in cool stars** [11443-11]

---

### ASTROMETRIC MISSIONS

---

- 11443 0N **Progress on the Astrometric Gravitation Probe design** [11443-17]
- 11443 0O **The Micro-arcsecond Astrometry Small Satellite: MASS** [11443-268]
- 11443 0P **RAFTER: Ring Astrometric Field Telescope for Exo-planets and Relativity** [11443-281]

---

### TELESCOPES FOR TRANSIENT FOLLOWUPS

---

- 11443 0Q **The Visible Telescope onboard the Chinese-French SVOM satellite** [11443-18]

11443 OR      **Development of an optical and near-infrared telescope onboard the HiZ-GUNDAM mission**  
[11443-19]

---

**JWST**

---

11443 OT      **Status of the James Webb Space Telescope mission** [11443-21]

11443 OW      **Preparing the JWST observatory for science observations** [11443-24]

---

**TRANSITING EXOPLANET MISSIONS I**

---

11443 10      **The ESA Ariel mission is ready for implementation** [11443-78]

11443 12      **PLATO telescope optical units: an update on working status** [11443-80]

---

**TRANSITING EXOPLANET MISSIONS II**

---

11443 14      **CHEOPS, the ESA mission for exo-planets characterization: early operations and commissioning results** [11443-82]

11443 16      **LOTUS: wide-field monitoring nanosatellite for finding long-period transiting planets** [11443-84]

11443 19      **The MARSU CubeSat: monitoring the activity and planetary transits of low-mass stars and young solar analogues** [11443-87]

---

**ENABLING TECHNOLOGIES: OPTICS AND OPTOMECHANICS**

---

11443 1B      **Optical space telescope without mirrors** [11443-89]

11443 1D      **Programmable microshutter selection masks in application to UV spectroscopy** [11443-91]

---

**ENABLING TECHNOLOGIES: DETECTORS AND ELECTRONICS**

---

11443 1L      **MAJIS/JUICE VIS-NIR FM and SM detectors characterization** [11443-137]

---

#### INTERFEROMETRY, FORMATION FLYING, AND STARSHADES

---

- 11443 1N **Far-infrared intensity interferometry for high angular resolution imaging** [11443-139]
- 11443 1R **Validation of diffraction models with experimental results from the Princeton starshade testbed** [11443-143]

---

#### EXOPLANET IMAGING MISSIONS I

---

- 11443 1U **The Nancy Grace Roman Space Telescope Coronagraph Instrument (CGI) technology demonstration** [11443-194]
- 11443 1W **Roman CGI testbed HOWFSC modeling and validation** [11443-196]
- 11443 1Y **Design of the vacuum high contrast imaging testbed for CDEEP, the Coronagraphic Debris and Exoplanet Exploring Pioneer** [11443-198]

---

#### EXOPLANET IMAGING MISSIONS II

---

- 11443 1Z **A space mission dedicated for the characterization of habitable rocky planets** [11443-199]
- 11443 20 **The Habitable Exoplanet Observatory mission concept** [11443-200]
- 11443 24 **Integration time adjusted completeness** [11443-204]

---

#### FAR-INFRARED AND MILLIMETER MISSIONS I

---

- 11443 27 **The 2020 SPICA telescope preliminary design and predicted performance** [11443-207]
- 11443 28 **Cryogenic system of the infrared space mission SPICA** [11443-208]
- 11443 29 **Mechanical cooler system for the infrared space mission SPICA** [11443-209]
- 11443 2A **ATSA: a cold, active telescope for Space Astronomy** [11443-269]

---

#### FAR-INFRARED AND MILLIMETER MISSIONS III

---

- 11443 2F **LiteBIRD satellite: JAXA's new strategic L-class mission for all-sky surveys of cosmic microwave background polarization** [11443-249]

11443 2G **Overview of the medium and high frequency telescopes of the LiteBIRD space mission**  
[11443-250]

---

**TECHNOLOGIES: WAVEFRONT SENSING**

---

11443 2K **Implementation of a dark hole maintenance algorithm for speckle drift in a high contrast space coronagraph** [11443-254]

11443 2L **Cross-fringe technique for sensing piston errors of segmented mirror telescope** [11443-255]

---

**TECHNOLOGIES: HIGH CONTRAST IMAGING**

---

11443 2M **Construction of EXIST (Exoplanet Imaging System Testbed) toward future space coronagraphs**  
[11443-256]

11443 2O **Experimental analysis of the achromatic performance of a vector vortex coronagraph**  
[11443-258]

11443 2Q **Wavefront control experiments with a single mode fiber at the High-Contrast Spectroscopy Testbed for Segmented Telescopes (HCST)** [11443-260]

---

**SOLAR SYSTEM AND HELIOPHYSICS**

---

11443 2U **Scientific processing pipeline for ASPICS coronagraph** [11443-264]

11443 2W **Focus mechanism for EXOMARS mission: lessons learned from preliminary design to space flight model delivery** [11443-266]

---

**POSTER SESSION: CUBESATS AND SMALLSATS**

---

11443 30 **First error budget of a deployable CubeSat telescope** [11443-95]

11443 31 **High-resolution deployable CubeSat prototype** [11443-96]

11443 32 **Non-contact vibration isolation technology demonstration on a CubeSat** [11443-97]

---

**POSTER SESSION: EXOPLANET IMAGING**

---

11443 37 **The Roman exoplanet imaging data challenge: a major community engagement effort**  
[11443-146]

- 11443 38 **A review of simulation and performance modeling tools for the Roman coronagraph instrument** [11443-148]
- 11443 39 **Prediction and evaluation of the image of the WFIRST coronagraph pupil at the shaped-pupil mask** [11443-149]

## **Part Two**

- 11443 3C **Habitable-zone observatory (HabEx) baseline 4-m telescope design and predicted performance** [11443-152]

---

### **POSTER SESSION: HIGH CONTRAST IMAGING**

---

- 11443 3J **Predicting contrast sensitivity to segmented aperture misalignment modes for the HiCAT testbed** [11443-158]
- 11443 3L **A sequential optimization procedure designed for Lyot coronagraph aiming to realize high contrast direct imaging for exoplanets** [11443-161]
- 11443 3N **Data processing for high-contrast imaging with the James Webb Space Telescope** [11443-163]
- 11443 3P **Exploiting symmetries and progressive refinement for apodized pupil Lyot coronagraph design** [11443-165]
- 11443 3R **Design of the life signature detection polarimeter LSDpol** [11443-167]
- 11443 3T **ExoSpec project: an exoplanet spectroscopy technology research collaboration based at NASA's Goddard Space Flight Center and Ames Research Center** [11443-169]
- 11443 3Y **Towards high throughput and low-order aberration robustness for vortex coronagraphs with central obstructions** [11443-174]
- 11443 41 **Mueller matrix maps of dichroic filters reveal polarization aberrations** [11443-275]

---

### **POSTER SESSION: WAVEFRONT SENSING AND CONTROL**

---

- 11443 42 **Phasing a sparse telescope** [11443-182]
- 11443 46 **Estimating low-order aberrations through a Lyot coronagraph with a Zernike wavefront sensor for exoplanet imaging** [11443-186]
- 11443 48 **Integrating bias and gain invariance with the generalized Anscombe transform for wavefront sensing** [11443-188]
- 11443 49 **Deep neural networks to improve the dynamic range of Zernike phase-contrast wavefront sensing in high-contrast imaging systems** [11443-189]

---

**POSTER SESSION: JWST**

---

- 11443 4D **Modelling the path length of aluminium seen by the detectors in the MIRI instrument on the JWST** [11443-32]

---

**POSTER SESSION: TRANSITING EXOPLANET MISSIONS**

---

- 11443 4P **The role of the instrument control unit within the ARIEL Payload and its current design** [11443-48]
- 11443 4Q **On the optical alignment of the PLATO cameras** [11443-49]
- 11443 4R **Product assurance for the PLATO Telescope optical unit** [11443-50]
- 11443 4S **A combined software and hardware data compression approach in PLATO** [11443-51]
- 11443 4T **A white light collimator for Plato camera integration support** [11443-52]
- 11443 4V **The instrument control unit of the PLATO payload: design consolidation following the preliminary design review by ESA** [11443-54]
- 11443 4X **Design and validation of the boot software for the instrument control unit of the PLATO mission** [11443-56]
- 11443 5I **Design of the electrical ground support equipment for the PLATO camera AIV** [11443-60]

---

**POSTER SESSION: WIDE FIELD SURVEY MISSIONS**

---

- 11443 59 **Data processing unit's hardware and application software description of the Near Infrared Spectro-Photometer: Euclid mission** [11443-69]
- 11443 5A **Pre-flight optical test and calibration for the Cosmic Infrared Background Experiment 2 (CIBER-2)** [11443-70]
- 11443 5B **The application software for the instrument control unit of the NISP instrument of the Euclid mission: final status and lessons learned after delivery of the flight version** [11443-71]
- 11443 5F **Photon counting and precision photometry for the Roman Space Telescope Coronagraph** [11443-271]

---

**POSTER SESSION: DETECTORS AND ELECTRONICS**

---

- 11443 5H **Multicore processor based instrument control and data processing units design for the SPICA instruments** [11443-104]
- 11443 5M **MVIC flight and flight spare sensor calibration** [11443-109]
- 11443 5Q **Detector fabrication development for the LiteBIRD satellite mission** [11443-114]

---

**POSTER SESSION: OPTICS AND OPTOMECHANICS**

---

- 11443 65 **Parameters for mirror selection: trades between glass ceramics, glass, metals, ceramics and cordierites** [11443-130]

---

**POSTER SESSION: INTERFEROMETRY, FORMATION FLYING, AND STARSHADES**

---

- 11443 66 **Linear formation-flying astronomical interferometry in low-Earth orbit: a feasibility study** [11443-177]
- 11443 6A **Broadband characterization of anti-reflection coated starshade optical edges for solar glint control** [11443-181]

---

**POSTER SESSION: FAR-IR AND MILLIMETER**

---

- 11443 6B **Development of EXo-Zodiacal Infrared Telescope (EXZIT) for observation of visible and near-infrared extragalactic background light** [11443-210]
- 11443 6C **Polarization angle measurement of LiteBIRD low frequency telescope scaled model** [11443-211]
- 11443 6D **Laboratory experiment of densified pupil spectrograph for the Origins Space Telescope** [11443-212]
- 11443 6F **Simulating electromagnetic transfer function from the transmission antennae to the sensors vicinity in LiteBIRD** [11443-214]
- 11443 6G **SPICA Mid-infrared Instrument (SMI): The latest design and specifications** [11443-215]
- 11443 6H **The calibration source assembly for SPICA/SAFARI instrument** [11443-216]
- 11443 6I **The 4K focal plane unit for SPICA's SAFARI far infrared instrument** [11443-217]
- 11443 6K **The mid-infrared spectrometer/camera (MISC) for the Origins Space Telescope** [11443-219]

- 11443 6L **Calibration strategy for the SPICA/SAFARI instrument** [11443-220]
- 11443 6R **A far infrared spectrometer for SPICA mission: optical E2E of SAFARI** [11443-226]
- 11443 6X **Evaluation of reconstructed angular error of a continuous rotating HWP for LiteBIRD** [11443-276]
- 11443 6Z **A polarization modulator unit for the mid- and high-frequency telescopes of the LiteBIRD mission** [11443-282]
- 11443 70 **The optical design of the Litebird middle and high frequency telescope** [11443-283]

---

**POSTER SESSION: SOLAR SYSTEM AND HELIOPHYSICS**

---

- 11443 73 **Selection of in-flight flat-field calibration dither pattern for the Solar Disk Imager of the Lyman-alpha Solar Telescope** [11443-234]
- 11443 74 **Setting the parameters for the stellar calibration of the SIMBIO-SYS STC camera on-board the ESA BepiColombo mission** [11443-235]
- 11443 78 **On-board de-spiking implemented by MAJIS, the VIS/NIR imaging spectrometer of JUICE** [11443-239]
- 11443 79 **The optical head of the EnVisS camera for the Comet Interceptor ESA mission: phase 0 study** [11443-240]
- 11443 7C **HYPSONS: a HYPerspectral stereo observing system for solar system exploration** [11443-243]
- 11443 7E **Simulations of stray light from the surface scattering of the Solar Corona Imager primary mirror** [11443-272]
- 11443 7G **Thermal-vacuum and security system of the characterization facility for MAJIS/JUICE VIS-NIR FM and SM detectors** [11443-277]
- 11443 7H **Characterization facility for the MAJIS/JUICE VIS-NIR FM and SM detectors** [11443-278]

---

**POSTER SESSION: MISSION DEVELOPMENT AND PLANNING**

---

- 11443 7I **Establishing a resilient flagships science program** [11443-44]