National Aeronautics and Space Administration

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AMES' EMERGING TECHNOLOGIES

"Then, she took a physics class..."

Natalie Batalha, *Becoming One of* ***Time's*** *'100 Most Influential'*

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Center Chief Technologist Corner

Welcome to the Chief Technologist (CCT) Corner. This is new to TechBytes, and will be included in this and future issues to provide highlights and updates of key areas of interest to Ames, the Office of the Chief Technologist (OCT), the Space Technology Mission Directorate (STMD), and the Agency. In this edition, I want to provide an introduction to the newly established Internal Research and Development (IRAD) investment process at Ames, and give an update of the Agency's TechPort tool.

NASA Ames has established a formal proposal process for IRAD investments. The purpose of the IRAD is to develop strategic technical capabilities in support of the Center competencies, and thereby enable science, technology, and engineering efforts for supporting future Agency missions.The advances in science and technology expected through this program will help make Ames more competitive, provide opportunities for technical risk reduction and/or increased cost effectiveness, and initiate potentially transformational solutions. Each year the Ames Research Center the Office of the Chief Technologist (OCT) and the Office of the Chief Scientist (OCS) will jointly release a Center Request for Proposals (RFP) for IRAD in late spring/early summer, with selection announcements in the Fall. FY18 IRAD proposals are due July 19. For more information on the Ames IRAD, including the full Request for Proposal (RFP), go to: https://www.nasa.gov/ames/irad18.

You are probably familiar with the TechPort database (techport.nasa.gov). TechPort is NASA's resource for collecting and sharing information about NASA-funded technology development. This purpose of the system is to allow the public to discover the technologies NASA is working on. In addition to continually updating the contents in individual technology entries (through the Mission Directorates), NASA is continually updating the database itself. Every new version adds features designed to enhance the user experience. The most recent update enriched user support and communication, and significantly improved the TechPort Application Programming Interface (API), which will be of interest to organizations harvesting TechPort data for additional analysis. At last report, TechPort contained information on 1,590 active technology development projects, and a historical collection of over 8,000 completed projects.

The solicitation for the Materials International Space Station Experiment Flight Facility Experiments (MISSE-FF) is seeking materials science and technology research proposals to define investigations to be conducted aboard the International Space Station (ISS). This call is specifically for NASA experiments that will fly as part of the MISSE-11 mission that is scheduled to fly on SpaceX-18 with an approximate launch date of December 2018. Currently, 2 zenith, 2 ram and 3 wake carriers are expected to be launched on MISSE-11. Proposals are due Friday, June 23, 2017. For more information see: https://www.nasa.gov/mission_pages/tdm/missex/index.html

If you have a story you'd like included in future editions of TechBytes, please contact Jill Bauman (jill.bauman@nasa.gov).

Sincerely,
Harry Partridge
NASA Ames Center Chief Technologist

ABOUT THE COVER

Natalie Batalha is the Lead Scientist for NASA's landmark Kepler Space Telescope mission has just named by TIME Magazine as one of the 100 most influential people in the world. Cover background image by D. Aguilar, Harvard Smithsonian Center for Astrophysics; cover photo by Dominic Hart

"Then, she took a physics class…" Natalie Batalha, Becoming One of Time's '100 Most Influential'

When Natalie Batalha was 15 years old, she bounded down the stairs and announced to her startled mother that she'd decided to become a philosopher.

Thirty-five years later, that declaration would land Batalha on Time magazine's list of the 100 most influential people on Earth. But the ranking would not be for her philosophical musings.

Instead, Batalha, 50, is one of the world's foremost planet hunters, a Marco Polo of the universe whose team has discovered approximately 4,000 new planets, some of which may turn out to be capable of supporting life.

But the need to answer the great philosophical questions about who we are, why we are here, and where we are going, was, and still is, at the heart of what Batalha does.

Spend time with Batalha, who earned her Ph.D. in astrophysics at University of California, Santa Cruz, and amid talk of transit photometry and spectroscopic methods, she'll speak about how human survivability depends on empathy and how empathy is deepened by knowledge. She'll describe how the cells in our bodies were manufactured in the core of stars which, therefore, connects every human on the planet, and talk about the poignancy of the moment she walked out of the redwoods at UC Santa Cruz after a day of studying lifeless planets and was overwhelmed with the idea of the fragility of our existence.

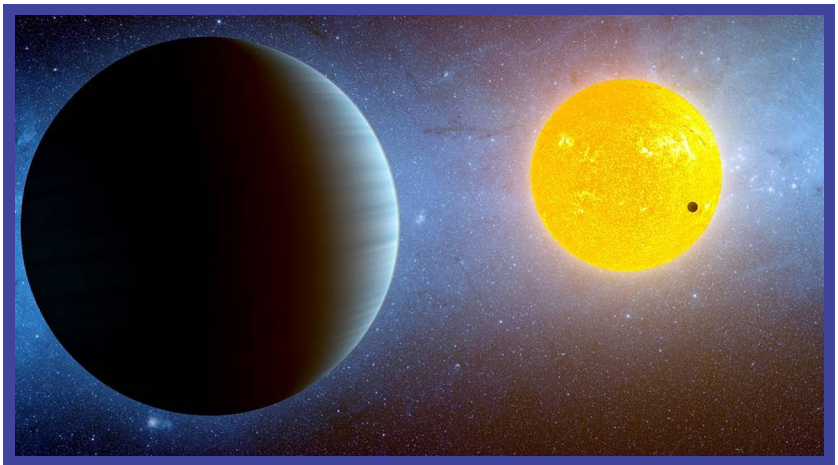
Discovery, she believes, is fundamental to human survival. And, right now, Batalha is at the forefront of a rapidly growing field of knowledge that a UC Santa Cruz astronomer described as "one wild ride."

The building that houses Batalha's office at NASA's Ames Research Center is flanked by a cracked asphalt road called Pioneer Avenue. But that's about the only nod to the game-changing work that is going on inside. The concrete structure is a warren of small offices and long fluorescent-lit hallways, with Batalha's workspace no different than any other, despite the fact she is lead scientist for one of NASA's most significant projects: to find Earth-sized planets that may lead us to an answer about whether we are alone in the universe.

Batalha came to science in a roundabout way. Her teen-age pronouncement that she would become a philosopher arrived after she became disillusioned with the Catholic religion she'd studied and read the 1970 novella, Jonathan Livingston Seagull. The book seeded the idea in her that the way to enlightenment was through the pursuit of knowledge.

Then, she took a physics class.

"When I saw the universe could be represented through numbers and equations, it blew me away,"



Artist's conception depicting the Kepler-10 star system. Kepler has discovered two planets around this star. Image Credit: NASA/Ames/JPL-Caltech

Natalie Batalha "Then, she took a physics class…" (continued)

Batalha says. "I thought, though mysterious, the universe is not just chaos. It's not a collection of meaningless, random events. If we can uncover the secrets of the universe through numbers, then what limits are there to what we can learn?"

Still, she hadn't planned to be become a scientist. That event happened at a summer internship at the Wyoming Infrared Observatory. On one of Batalha's first days there, her faculty advisor handed her a bunch of data concerning a star called HL-Tau and a surrounding disc from which, it was thought, exoplanets could form. The problem was, the information wasn't making sense.

By the end of the summer, Batalha had figured out why.

"I was given a puzzle to solve," Batalha says. "Putting the pieces together was challenging but fun. And just like a puzzle, there was immense gratification when it was solved and you could see the big picture. But here, as often is the case with science, I got to see something that no other human had ever seen before."

Her life would take another turn, however. By the time Batalha took her last final exam at University California, Berkeley and decided to go to graduate school, she was pregnant with her and her husband's first child.

What would follow was years of child-rearing — she has four children — mixed with the demands of research and her husband's own astrophysics career.

Raising a family while studying the stars was not easy. Even though her professors at UC Santa Cruz were accommodating, there were missed conferences, unconventional hours, and summer spent with her children instead of doing research, she says.

Still, her then-advisor, UC Santa Cruz Professor of Astronomy Steve Vogt, who built a planet-hunting spectrometer that was mounted on the 10-meter Keck-I telescope in Hawaii, remembers her talent and drive. Given only a short window of time to use the powerful instrument, Batalha figured out a way for them to get the most bang for their truncated buck.

"By golly, she lowered her head and muscled through it and made a fine project out of it," he says.

Then, chance stepped in.

As Batalha tells it, she was sitting in the office of Gibor Basri, a professor of astrophysics at UC Berkeley and a member of her doctoral thesis committee, when she noticed a report on his desk from a NASA Ames scientist about a new way to detect earth-sized planets circling other stars.

Called transit photometry, it measured the brightness of a star and then looked for dimmings that would indicate the presence of an earth-sized planet as it orbited the star. Batalha, who had been studying magnetic activity and sunspots on young stars, wondered how the method could distinguish between sunspots and planets and promptly wrote the scientist a letter.

By February, 2000, she was working with the NASA Ames team on that question and by the next year, a plan to launch a space telescope called Kepler which used transit photometry, was given the go-ahead thanks in part to her help. She also won a teaching position at San Jose State University about the same time.

Batalha gets up and begins to sketch a wave of disordered dots on her office whiteboard, describing the moment she and other Kepler scientists realized they'd accomplished what they set out to do.

"The brightness measurements looked like beads on a string," she says, drawing a line of more distinct dots through the chaotic scattering to mark the spot where a star's light dimmed. "At that scale, you couldn't see the measurement noise. It was just beautiful."

Even more "beautiful" was the team's discovery in 2015 of an Earth-sized planet orbiting a star in what is known as the "Goldilocks Zone," the sweet spot where a planet is just the right distance from its star so that liquid water might pool on the surface. Two to three dozen similar planets have now been discovered.

So, is there intelligent life out there?

Batalha says she hopes there is but it may be up to her eldest daughter, an astrophysicist who is also studying exoplanets, to answer.

Batalha lays out upcoming NASA undertakings: a project to help characterize the atmosphere of the most promising planets and, later, another space-based telescope that can look at the surface structure of these planets to determine if they might be habitable. The latter wouldn't launch until 2030.

"I'll be at retirement age by then," Batalha says and smiles. "Luckily, my daughter will be able to pick up where I leave off." ■

Article contributed by Peggy Townsend, UC Santa Cruz.

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Bio-manufacturing Space Technology Research Institute (STRI) Initiated

Establishing sustainable human exploration missions on Mars and other far-reaching destinations requires increased on-site manufacturing, rather than solely launching supplies from Earth. Bio-manufacturing technologies will be a critical element of this new approach as they generate a variety of necessary mission products that conventional physical and chemical processes are unable to make.

Multifunction Mars Base. Image Credit: NASA

One of the Space Technology Mission Directorate's (STMD) recently selected Space Technology Research Institutes (STRIs) is specifically focused on space-based bio-manufacturing (https://www.nasa.gov/press-release/nasa-selects-proposals-for-first-ever-space-technology-research-institutes). An STRI is a university-led, multi-institution, multi-disciplinary, five-year grant award that may receive up to $15M in total funding. The bio-manufacturing STRI creates collaborations among academic and commercial partners to develop innovative biotechnologies that enable sustainable bio-manufacturing practices in space, as well as provide numerous terrestrial commercial applications.

Under the inaugural STRI solicitation, NASA selected the proposal "Center for the Utilization of Biological Engineering in Space" (CUBES), led by principal investigator Adam Arkin at the University of California, Berkeley. Other CUBES team members include Stanford University, Utah State University, the University of California, Davis, and commercial partners Autodesk and Physical Sciences, Inc. The CUBES team will conduct highly interdisciplinary, cutting-edge biotechnology research and development to create integrated, multi-functional systems that will culminate in products such as food, fuel, materials and pharmaceuticals.

NASA Ames personnel will serve as the NASA contracting officer's representative for this grant and will work with a team of NASA engineers and scientists from multiple centers. The CUBES STRI is planned to begin by summer 2017. ■

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Space Technology Research Fellows at Ames in 2017

The NASA Space Technology Research Fellowship (NSTRF) program contributes materially to the NASA Space Technology Mission Directorate's (STMD) goal of developing "revolutionary, high-payoff technologies." Ames is again proud to host a substantial number of Fellows in 2017, in the belief that NSTRF not only raises technology readiness levels for NASA and advances the Fellows' research by exposing them to Ames' broad range of knowledge and expertise, it also contributes significantly to the culture of innovation at Ames.

Ames is hosting 31 Fellows this year, and 22 Ames researchers will serve as Research Collaborators (or mentors) for 1 or more Fellows. The Fellows' research runs the gamut from traditional Ames' strengths, such as thermal protection and CubeSats, to new fields (to Ames) such as automated construction and digital structures. Below is a list of the active Fellows assigned to Ames and their Research Collaborators. ■

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CLASS	FELLOW	UNIVERSITY	RESEARCH COLLABORATOR
NSTRF13	Christopher McBryde	Georgia Institute of Technology	Chad Frost
NSTRF13	Nicholas Cheney	Cornell University	Vytas Sunspiral
NSTRF13	Ethan Ritz	Cornell University	Charles Bauschlicher
NSTRF13	Anthony Harness	University of Colorado, Boulder	Elwood Agasid
NSTRF13	Zakary Littlefield	Rutgers University	Xavier Bouyssounouse
NSTRF13	Daniel Cellucci	Cornell University	Kenny Cheung
NSTRF13	Electa Baker	Vanderbilt University	Terry Fong
NSTRF13	Jessica Cardenas	New Jersey Institute of Technology	Eduardo Almeida
NSTRF14	Adam Sidor	Georgia Institute of Technology	Robin Beck
NSTRF14	Przemyslaw Lasota	Massachusetts Institute of Technology	Terry Fong
NSTRF14	Michael Watterson	University of Pennsylvania	Trey Smith
NSTRF14	Simon Vecchioni	Columbia University	Lynn Rothschild
NSTRF14	Joseph Bartels	Carnegie Mellon University	Matt Deans
NSTRF14	Benjamin Jenett	Massachusetts Institute of Technology	Kenny Cheung
NSTRF14	Jeffrey Friesen	University of California, San Diego	Massimo Vespignani
NSTRF15	Jennifer Case	Purdue University	Arno Rogg
NSTRF15	Steve McGuire	University of Colorado, Boulder	Padraig Michael Furlong
NSTRF15	Casey Heidrich	Georgia Institute of Technology	Brandon Smith
NSTRF15	Elizabeth Cha	University of Southern California	Terry Fong
NSTRF15	Taiyo Wilson	University of Illinois at Urbana-Champaign	Michael Barnhardt
NSTRF15	Andrew Sabelhaus	University of California, Berkeley	Adrian Agogino
NSTRF15	Adam Koenig	Stanford University	Chad Frost
NSTRF16	Eugene Fang	Carnegie Mellon University	Michael Furlong
NSTRF16	Mallory Daly	University of California, Berkeley	Massimo Vespignani
NSTRF16	Colin Burke	University of California, Berkeley	John Lawson
NSTRF16	William Sanchez	Massachusetts Institute of Technology	Jose Benavides
NSTRF16	Ashley Carlton	Massachusetts Institute of Technology	Ann Patterson-Hine
NSTRF16	Julian Whitman	Carnegie Mellon University	Stefan Schuet
NSTRF16	Nathaniel Skolnik	University of Illinois at Urbana-Champaign	Mairead Stackpoole
NSTRF16	Christine E. Gregg	University of California, Berkeley	Kenny Cheung
NSTRF16	David Zhenzhong Dang	University of Michigan	Eric Stern
NSTF15	Alden Yellowhorse	Brigham Young University	Kenny Cheung
	Andrew Leibowitz	CalTech	David Hash/Brett Cruden
NSTRF16	Julian Brew	Georgia Institute of Technology	Stefan Schuet
	Caitlin Chapin	Stanford University	Brandon Smith/G Ponchak
	Aliyeh Mousavi	Stanford University	Josh Alwood
NSTRF16	Ashley Carlton	Massachusetts Institute of Technology	Ann Patterson-Hine
NSTRF16	Colin Burke	University of California, Berkeley	John Lawson
NSTRF15	Emily Matula	University of Colorado	Daniel Barta
NSTRF15	Kyle Doyle	Cornell University	Erik Komendera

Ames' "Co-Optimized Blunt-Body Re-Entry Analysis (COBRA) for Moving Vehicles" Gets Honorable Mention in Invention of the Year Awards for 2017

On June 2, the Office of the General Counsel announced the winners of the Invention of the Year (IOY) Awards for 2017. Ames' "Co-Optimized Blunt-Body Re-Entry Analysis (COBRA) for Moving Vehicles" got Honorable Mention.

COBRA is a mission optimization and analysis method for optimal shapes for hypersonic vehicles that was developed to move beyond heritage based vehicle designs and provide a highly efficient automated approach to explore a large design space of thousands of vehicle concepts. The method utilizes parametrically defined analytic vehicle shape classes in combination with engineering analysis through a multi-objective optimization algorithm along with engineering judgment to quickly down-select the large design space to a handful of optimum viable vehicle concepts.. The result of this is a reduced set of candidate vehicle concepts which can then be efficiently evaluated using higher fidelity analysis enabled by key automatic surface and volume grid generation required by the embedded physics analysis processes for each parametric shape without the need for extensive human involvement. Since the majority of this process is automated it provides significant time savings over state of the art mission optimization approaches which can take months resulting in cost savings and an increase in future mission safety while maintaining optimized performance. In the course of the COBRA development, a parametric analytic shape class was also innovated referred to as Co-Optimized blunt body Re-entry Aeroshell-Super Quadric (CobraSQ).

In addition to supporting NASA solar system exploration, COBRA has commercial applications in the areas of aeronautics, computer software, transportation, aerospace, and defense.

Johnson Space Center's "Inflatable Spacecraft Vessel" won the NASA Government Invention of the Year. ■

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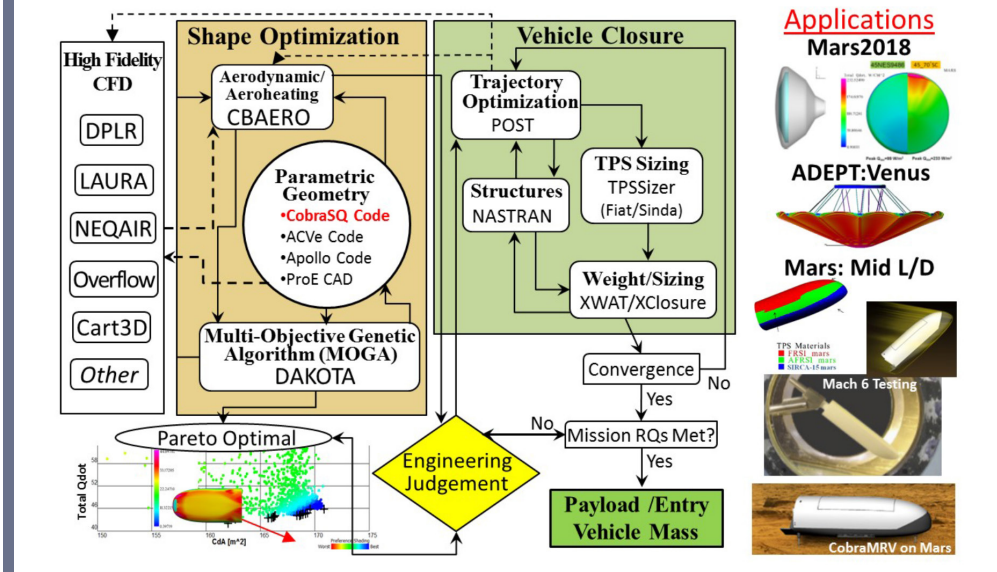

Johnson Space Center's "Inflatable Spacecraft Vessel" won the NASA Government Invention of the Year. Source: Ames-partnerships technology-co-optimization-of-blunt-body-shapes-for-moving-vehicles

Upcoming Activities & Events

June 1 – September 20, 2017

Events & Conferences

SBIR Workshop
June 25-27, 2017
NASA Ames Research Center, Building 152

59th Electronic Materials Conference
June 28-30, 2017
University of Notre Dame
South Bend, Indiana

Fluids Engineering Division Summer Meeting (FEDSM)
July 30-Aug 3 2017
Hilton Waikoloa Village, Waikoloa, Hawaii

Autonomy for Future Science Mission Directorate Missions
July 21, 2017
Ames Research Center

NASA-DoD Biology Workshop
July 31-Aug 3, 2017
Ames Research Center

Small Satellite Conference
Aug 5-10, 2017
Utah State University, Logan, Utah

International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2017)
August 6-9, 2017
Cleveland Convention Center,
Cleveland, Ohio

Conference on Smart Materials, Adaptive Structures and Intelligent Systems (SMASIS)
September 18-20, 2017
Snowbird Ski and Summer Resort,
Snowbird, Utah

NASA Solicitations

Early Stage Innovation
Solicitation: NNH17ZOA001N-17ESI_B2
Notice of Intent (Strongly encouraged):
June 2, 2017
Proposals Due: June 30, 2017

Planetary Instrument Concepts for the Advancement of Solar System Observations (PICASSO)
Solicitation: NNH17ZDA001N-PICASSO
Step 1 (NOI) ***Due: Sept. 14, 2017***
Step 2 (Proposal) ***Due: Nov. 16, 2017***

Ames Solicitations

FY18 Center Innovation Fund (CIF)
Request for Proposal release ***5/29***,
proposals due ***6/30***.
For more info, see:
https://www.nasa.gov/ames/cct/cif18

FY18 Internal Research and Development (IRAD)
Request for Proposal release ***6/12***,
proposals due ***7/19***.
For more info, see:
https://www.nasa.gov/ames/irad18

External Solicitations

Defense Advanced Research Technologies Office
Proposed research should investigate leading edge approaches that enable revolutionary advances in science, technologies, or systems at the intersection of biology with engineering and the physical and computer sciences. Topics areas include: Developing technologies that leverage ecological diversity and/or help support human operations in extreme environments (ocean, desert, space, etc.).
Solicitation: HR001117S0030
Open Period: ***April 26, 2017 to April 26, 2018***