



THE MASTERMINDS

From killing planets to creating artificial intelligence— meet some of Pasadena's boldest thinkers, truth seekers, and inspired visionaries who, in their quest for knowledge, have illuminated our world.

BY LINDA IMMEDIATO



THE 19TH CENTURY GERMAN PHILOSOPHER ARTHUR SCHOPENHAUER ONCE SAID: "TALENT HITS A TARGET NO ONE ELSE CAN HIT; GENIUS HITS A TARGET NO ONE ELSE CAN SEE." PASADENA HAS LONG BEEN HOME TO SOME OF THE WORLD'S GREATEST MINDS WHO, THROUGH GROUNDBREAKING DISCOVERIES AND SCIENTIFIC FIRSTS, HAVE HIT TARGETS NO ONE ELSE COULD SEE. OUR FAMOUS PETRI DISH, THE CALIFORNIA INSTITUTE OF TECHNOLOGY (CALTECH) HAS INCUBATED 32 NOBEL LAUREATES; IT WAS WHERE DR. CHARLES RICHTER DEvised HIS EARTHQUAKE MEASURING SYSTEM, WHERE MEDICAL BREAKTHROUGHS WERE MADE, WHERE ALBERT EINSTEIN SPENT THREE WINTERS AS A VISITING ASSOCIATE, WHERE FAMED PHYSICIST RICHARD FEYNMAN RESEARCHED QUANTUM MECHANICS AND TAUGHT YOUNG MINDS, WHERE ANTI-MATTER AND THOUSANDS OF NEW STARS AND GALAXIES WERE FOUND. AND EVER SINCE LAUNCHING THE FIRST U.S. SATELLITE INTO ORBIT IN 1958, CALTECH'S SPIN-OFF, NASA'S JET PROPULSION LABORATORY (JPL) HAS BECOME THE GLOBAL EPICENTER FOR SPACE EXPLORATION, RECENTLY SENDING FACT-FINDING ROBOTS TO MARS AND TO THE FARTHEST REACHES OF OUR SOLAR SYSTEM. HERE ARE A FEW COLLECTED STORIES, JUST A SAMPLE OF THE EXTRAORDINARY LOCAL MEN AND WOMEN WHO HAVE HELPED DEFINE PASADENA AS A HUB OF INNOVATION.

 **Dr. Arthur Riggs**
The Synthesizer



Dr. Arthur Riggs was a married student when he attended Caltech in 1960, and he described his early experience there "as a nice place to be." Though he says initially he was worried how he would fare at the top institute in the country. "I managed to do ok, and it didn't take too long before I knew I was going to be all right," he says. These are humble words from the man who helped jumpstart the entire field of biotechnology and genetic engineering. Through his research he figured out how to synthesize DNA, and helped create the synthetic human insulin used to treat diabetes.

In 1975, Dr. Riggs published a landmark paper on DNA methylation and epigenetics. "This discovery of DNA methylation led to some fancy therapies," says Dr. Riggs. Those "fancy therapies" include effective treatments for breast and colon cancer. "I am proud of that paper. It stimulated other work and has stood the test of time. I guess it was a pioneering paper," he adds shyly.

In 2006, Dr. Riggs, now director of the Beckman Research Institute at City of Hope, was inducted into the National Academy of Sciences (NAS). The NAS, established in 1863 by Congress and signed by President Abraham Lincoln, is a private organization that acts as an advisory board to the US government. Only the top scientists in the country are elected by their peers to become members.

"The most rewarding part of my research," says Dr. Riggs, "is being able to advance medical science, and help people with diabetes and with cancer. I'm extremely lucky to be able to do that. I'm also very pleased that I've helped to understand more about how life really works."

 **Dr. Mike Brown**
The Man Who Killed Pluto



About 15 years ago astronomer and Caltech professor Mike Brown became obsessed with finding a new planet. He says if you asked anyone what he was like back then, they'd say it was all he could talk about.

"As a child," Brown says. "I thought we knew everything about the solar system. It wasn't until I learned more and more that I realized there could be things left at the edge of the solar system."

Night after night he searched. And one evening from a computer in his office at Caltech, he found it, in a picture of a field of bright stars. He called his wife immediately. "I remember I said, 'I just found a planet.' And I joke that she said something, like, 'That's nice honey don't forget to pick up the milk,'" Brown laughs. But Brown didn't know the storm of controversy that would swarm his discovery. "As soon as I discovered the planet I assumed it would be called the 10th planet," recalls Brown. "I imagined if I was a kid how excited I would have been at the discovery of a 10th planet. I'd have thought it was the coolest thing."

But this new celestial body actually called into question Pluto's status as a planet. It took a year of meetings and committees for astronomers to decide Pluto's fate. And in the end Pluto was demoted from planet status, kicked out of the VIP club of the big boys. Sadly too, Brown's 10th planet, named

Eris, was also deemed not a planet. The two are now called "dwarf planets."

Brown received hate mail from third graders and adults, and he writes poignantly about this time in his life in a book called *How I Killed Pluto and Why It Had It Coming*.

"I think to them, Pluto represents some memory of childhood, that is now sadly broken," says Brown, who now gets obscene phone calls at 3 am on Saturdays. "I think it's the same kids who wrote the letters," laughs Brown. "They went to college, got drunk and think, 'hey, let's call the guy who ruined that planet.'" There are currently four "Save Pluto" facebook profile pages.

But in all of this Brown sees the silver lining. "It's not that we lost Pluto," he says, "we gained knowledge. I was given a marvelous opportunity to talk about the solar system with the public, and it's so infrequently a part of their lives. I take solace in knowing that I'm not the first person to kill a planet. Copernicus, he got rid of the sun and moon as planets. I guess I'm following in his footsteps and if I have to kill another planet to increase our knowledge and understanding of the universe, I will."

 **Dr. Charles Elachi**
The Rocketman



For Dr. Charles Elachi, Director of the Jet Propulsion Laboratory and Vice President of the California Institute of Technology, there were two defining moments that led him to his highly regarded career in space sciences. The first happened when he was a stargazing 11-year old, living in

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Lebanon, and over the radio waves came news that Sputnik had launched. The second pivotal experience happened while he was a student at Caltech and he watched the lunar landing and Armstrong step onto the surface of the moon. “I realized during those two key moments that in science these things are possible, space travel and space exploration can be done.”

With degrees in physics, engineering, geology and electrical sciences, Dr. Elachi led NASA teams in developing shuttle imaging radar, which along with satellite instruments are used to map the earth and other planets. In the Sahara desert, this technology was used to find ancient rivers that were once trade routes, now covered up with sand. It was used to penetrate Venus’ clouds, and look through the haze covering Titan, one of Saturn’s moons, to find lakes and mountains.

“For me research is about gaining new knowledge, to be puzzled about something and then get the answers, that makes you feel good,” says Dr. Elachi. “And proud of yourself as a human being.”

The award-winning scientist has authored over 200 publications in the fields of active microwave remote sensing and electromagnetic theory, and he holds several patents for his work in those areas. He joined JPL in 1970, becoming Director in 2001. “It’s amazing,” Dr. Elachi says of his tenure at JPL. “I work with 5,000 of the most ingenious, imaginative, passionate and bold people you can find anywhere. I don’t recall a single day when I didn’t look forward to going to JPL.”

Elachi recounted the early history of JPL during a talk about the Mars Rovers at an Art Center Design Conference in 2008 (ted.com/talks), he called the founding members of JPL “a bunch of kids from Caltech trying to mix chemicals to see what ones could blow up more.” They were called “the rocket boys” and Elachi claims they eventually “blew up a shack at Caltech and were sent off to do their testing in the Arroyo” and JPL was born in 1936.

But JPL has come a long way from testing rockets. “It is the hub of exploration in our solar system,” says Elachi, “if you walk in the building behind my office, you will see we are monitoring all the spacecrafts that are all over the solar system, the two Voyagers on the edge of the solar system, Cassini in Saturn’s orbit, the Mars Rovers and spacecrafts heading to comets, we have telescopes mapping galaxies—it’s all going on in that building. If you sit down and think about it—it’s kind of mindboggling. Here in Pasadena, we really are at the center of the Universe.”

Mark Maimone The Prime Rover Mover



Mark Maimone remembers when the Viking mission landed on Mars. “I was about 10 years old or so and I was very excited to see the pictures, to see the surface of another world.” And while this ignited an interest in space exploration, it wasn’t until after grad school that he began working professionally in that realm. He had visited JPL during a

NASA fellowship and later one of his supervisors called him from the Atacama Mountains in Chile where he was testing robots and offered him a job at JPL.

For over two years he worked on the development and operations teams for the MER (Mars Exploration Rovers) mission. Named Spirit and Opportunity, these robots were sent to roam the red planet and search rocks and soil for evidence of water. Maimone helped develop their Autonomous Navigation capabilities and ground software for automated analysis of the rovers’ arms, one of which housed an instrument deployment device, used to collect samples.

Sadly, since 2009 Spirit has been stuck in the sand, while his twin continues his journey on the opposite side of the planet. “We always want to make things better,” says Maimone of the setback. “We come up with ways to take advantage of past missions.” And with that optimism comes the next rover—Curiosity, essentially a fully equipped robotic science lab, but this time armed with Maimone’s new navigation software that includes depth perception (stereo vision), visual odometry, hazard detection and avoidance and path planning. Four times the size of the MER robots Curiosity will contain a laser that can collect data remotely.

Although part of his job entails “talking” to the rovers once a day, Maimone says he doesn’t tend to personify inanimate objects. “But my wife calls Spirit and Opportunity her two step sons,” he laughs.

That’s not to say he doesn’t have feelings about them. During a mission launch, there’s a sort of viewing party at Caltech, where colleagues and families wait breathlessly for news. You see, after years of research and work, the rovers are essentially hurled to Mars, and they enter the atmosphere at potentially destructive speeds, relying on landing gear—a parachute, airbags and retro rockets—to work, and it all happens in just seven

minutes. This is a critical phase they call the “seven minutes of terror.” Since it takes 10 minutes for the news to reach Earth, the lag time builds tension and when the rovers transmit their first signals, a collective sigh of relief goes up, tears are shed and hugs exchanged. “Knowing something you’ve worked so hard for was a success is so thrilling,” says Maimone. “It’d be nice if I could go myself, but for now I can send the next best thing—a rover.”

Dr. Paolo Pirjanian The Robot Deviser



Dr. Paolo Pirjanian began his work in the U.S. in a robotics lab at USC, where he got his post-doctorate creating multiple robots that work together to perform a task. These cooperative robots earned him a job at JPL, where he researched, developed and tested robots (in the Arroyo) that would eventually be able to go to Mars and build structures, so that when humans arrived, they’d already have a place to live.

It had been his childhood dream to work for NASA. “I hadn’t imagined I would have ever left,” he says. But in 1999, Bill Gross of Ideallab, a Pasadena-based Think Tank, approached him with his vision—robots for the consumer market. He was “enticed” by the challenge. “To develop these products that are intelligent, that you can leave on their own to do a task, and they have to be affordable, it was going to be a massive challenge,” says Dr. Pirjanian, who also worked on the Mars rovers while at JPL. “To build the rovers,” he explains, “there were no budget constraints and the majority of the time they are manually controlled from Earth.” For the consumer, they have to be able to take it out of a box and just press a button.

This year, Dr. Pirjanian’s company Evolution Robotics introduced Mint, an automatic

floor-cleaning robot with an indoor GPS. He credits its development in part to partnering with Idealab. "It's dynamic and un-bureaucratic," Dr. Pirjanian says of the tech think tank. "If something had to happen, if a decision had to be made, it could be made instantly. There are very smart people at Idealab and not just in terms of technology, in business, marketing and that combination along with a very creative team, enable them to do things bigger and better."

Dr. Pirjanian believes in 10 years we will all have robots in our homes. "But they won't be the Hollywood human-like robot ready to take over the world," he says. Those robots are a long way off largely due to the fact that they'd be way too expensive to produce right now. "But you will have robots in your car, your watch, cell phone, washing machines," he says. "I know the Mint isn't very sexy from a tech point of view. But floor cleaning is a foray into the consumer space, and eventually it will provide more technologies. "In 25-50 years these early robots will evolve and we'll have garden robots, robots to take care of the elderly, deliver packages, robot soldiers, robots to wash the dishes and put the kids to bed," Dr. Pirjanian says. "It's not a matter of if this will happen, it's a matter of when."

 **Rachel Hodos**
The Rising Star



"I still pinch myself when I tell people I work for NASA," says Rachel Hodos, associate software engineer at JPL. "There's sort of this magical aura to JPL. You really can feel the significance of the work being done there, and feel the excitement of possibility, the possibility of discovering things that might have implications for our human race. People there walk around with smiles on their faces all the time."

In 2008, Hodos participated

in an undergraduate research program through UCLA working on a project for JPL, in which she utilized her math skills (she has a B.S. in Math from the University of Houston) to compute trajectories to solve surface representation problems surrounding tubes in space. She feared she made a bad impression on her supervisor Martin Lo. "We had no idea what these tubes were in space. We just couldn't comprehend what they were. So the first week I was just deathly afraid to meet him and ask him questions. But eventually I took charge of my team and we did some really interesting things. I guess I impressed him." She must have because Lo asked her to come back for an internship, before hiring her full time.

Hodos is currently working on three different earth science projects, two involving climate change—one to measure aerosol and one preparing data from satellites for the next International Panel on Climate Change. "I never thought I'd be measuring aerosol, but it's exciting to be a part of science that is so relevant."

In fact, Hodos, never thought she'd be involved with science at all. "I've always loved math," she explains. "But it wasn't until I got the job at JPL, that I finally realized that my fulfillment in life is going to come from my love of math and using it to solve real world problems. That was the part that was missing that I discovered, I could actually use math to help people."

 **Dr. A. Linn Murphree**
The Visionary Inventor



Recently Dr. A. Linn Murphree lost lifelong colleague Dr. Nancy Mansfield. She had worked closely with Dr. Murphree offering grief counseling to the families of the patients he treated for a rare cancer of the eye called Retinoblastoma, which affects infants and young children. "Her work pointed out to

us that Post Traumatic Stress Syndrome (PTSS) is very prevalent," says Murphree. "It's not just associated with Katrina or Iraq or traumas like that. It can affect whole families especially when it's a child that's the patient. With Retinoblastoma there is potential for blindness and death, and incredible stresses build during the long treatment process, which entails months spent going to hospitals. Nancy observed that parents and siblings of the child affected showed signs of PTSS. She was an integral part of my work and she will be greatly missed."

In an effort to minimize the stress of hospital visits and costs of traditional treatment of Retinoblastoma, Dr. Murphree created a new device, referred to as an "eye port."

A 10 month old with Retinoblastoma will typically have to undergo full body chemotherapy, every month over the course of many months. However, the chemo is really only needed to treat the eyes, 15 grams, a tiny fraction of the body, so 99.9% of the chemo is going to areas that don't need it. And the cost is huge. Dr. Murphree's eye port, a device that rests in the eye delivering consistent chemo just to the area affected, will not only be a more effective treatment, but one that costs much less.

A La Cañada resident, USC professor, and the director of The Vision Center at Children's Hospital Los Angeles, Dr. Murphree was recently awarded a \$1 million grant from the National Cancer Institute (NCI) to begin clinical trials on his "eye port" device. If effective, this new device could fundamentally change traditional treatments not only for a number of eye diseases like macular degeneration, but for other cancers as well, opening the door to create ports designed for other organs.

"The most rewarding part of my research," says Murphree, "is knowing that I made a difference in families where there is such a distraught response to the diagnosis."

There is something special about the eye, people say it's the soul, but it has a place in our culture more than any other part of the human body. And having a role to play in preventing vision loss. That feels good."

 **Dr. Pamela Bjorkman**
The Conscientious Observer



As a macro-molecular structural biologist and Caltech professor Dr. Pamela Bjorkman, has spent years

researching the smallest parts of our bodies. Her work focuses on the structure and function of molecules and their involvement in cell recognition, and specifically in how they mediate recognition in the immune system.

Last year Bjorkman and her team discovered that the HIV virus had very little spikes, not a lot of area for antibodies to grab on to. The antibodies have two arms but were only making contact with one arm due to the lack of a foothold on the virus. "This suggests that antibodies as they are now are not very effective," says Dr. Bjorkman. "But if we can engineer them with longer arms they could be very effective for a specific strain of HIV." It's a breakthrough that has AIDS researchers particularly excited. It could lead to a treatment for the currently untreatable strain of HIV effecting the populations of the third world, in places like India and Africa.

For Dr. Bjorkman her life's work represents the idea that you don't really know something until you can really look at it. "Until you see the structure of things, you don't really know how they function," she says. "Chemistry is looking at the structures and interactions. If you know that there are these proteins and you know what they look like you might know what they do in a cell. From our point of view you need to know what they look like before you know how they interact with each other." ☺