PEOPLE IN ASTRONOMY

GIBOR BASRI

Gibor Basri is Professor of Astronomy at the University of California, Berkeley. He grew up in Colorado and went to Stanford University for his B.Sc. Then he returned to Colorado for graduate school in the department then called Astrogeophysics, where he wrote his thesis about the chromospheres of supergiant stars. Subsequently, he was one of the astronomers who finally proved that brown dwarfs really exist. He was awarded a Miller Research Professorship to continue that work. More recently, he became involved with the Kepler project as a Co-Investigator. That NASA mission has now found lots of new extrasolar planets using the transit method. Professor Basri studies the stars that the mission is observing. He has worked with high-resolution spectroscopy, model stellar atmospheres using computers, and high precision photometry. He works in the optical, ultraviolet, and infrared regions of the spectrum. From 2007-2015, he was the founding Vice Chancellor of Equity and Inclusion at UC Berkeley.

WHAT ARE YOU MOST INTERESTED IN NOW?

I have always studied magnetic fields on stars: their role in star formation, stellar magnetic activity, and more recently the effects of stars on planets. I am also interested in the formation of stars and planets, and in substellar objects (brown dwarfs). I got involved in the debate on the definition of a “planet”: is Pluto a planet, and where is the line between brown dwarfs and planets? That was a lot of fun; I interacted with the public and the media in an entertaining way. It was a good way to inform people about all the advances that have occurred in our understanding of planetary systems. The Kepler mission is of broad interest because it found that Earth-sized planets are common around other stars. I am now using Kepler data to study starspots and related phenomena.

WERE YOU VERY SURPRISED THAT ALL OF A SUDDEN WE HAVE HUNDREDS OF NEW PLANETS OUTSIDE OUR SOLAR SYSTEM?

I wasn't surprised that they exist because of what I knew about star formation, but the particular discoveries have been surprising and interesting. The initial discoveries of brown dwarfs and extra-solar planets in 1995 made that year very exciting. It was one of those convergences in science where people are looking and looking and being frustrated, when all of a sudden there are major breakthroughs. It was very thrilling to be part of that process. Now there are many new techniques being used to find smaller and smaller planets. The Kepler mission used transits to find the smallest planets to date. New transit missions are about to take its place and find planets closer to us.

WHY DO YOU THINK IT TOOK SO LONG TO FIND BROWN DWARFS?

It was partly a matter of technology development. They are very faint and people weren't looking quite hard enough, basically. And it was also a matter of developing the right tests to be sure that we have brown dwarfs. We first identified some brown dwarfs because they had lithium in them, which was a bit of a complicated argument, but direct proof of a cool nuclear core. When Gliese 229B was announced shortly thereafter, it was a no-brainer since it was so cool that it couldn't possibly be a star. Once people realized that you could find them, everybody went after them, and they just started dropping out of the sky, so to speak. Also, the first sensitive all-sky infrared surveys started up around then, and they have been a major source of new brown dwarfs.

WHAT IS YOUR PERSONAL METHOD FOR FINDING BROWN DWARFS?

I got into this game mostly because of the advent of the Keck telescopes. I was privileged to be a Keck user and wanted to find something exciting to do with the new world's largest telescopes. The idea of the new lithium test for brown dwarfs had already been suggested by astronomers at the Canary Islands, but they were finding that their telescope was not quite up to the task. So I got involved in that and we were lucky enough to make the first discoveries and confirm that brown dwarfs exist.

The basic idea is that stars will destroy lithium when they start their hydrogen fusion. Most brown dwarfs will never get hot enough to destroy lithium, so they will retain it. So you can do a simple spectroscopic test to see if lithium is still present or not. If a star is a very faint red object and it shows lithium, then it is probably a brown dwarf.

Along the way, in applying that test carefully, we discovered that the age scale for young open clusters was off. It turns out they are all about 50 per cent older than we had thought.

This is because the normal way for finding the ages of those clusters involves high-mass stars turning off the main sequence, and those stars have convective nuclear burning cores. Convective overshoot is a poorly understood process, but the cores of those stars can basically grab extra hydrogen and live longer. The stellar evolution people were aware of this potential problem, but they didn't have a way of calibrating how much hydrogen would be grabbed. We know how long it takes stars to destroy lithium. You look down the pre-main sequence until you see that lithium is not yet destroyed, you see how bright those objects are, and that gives you the age (since they get fainter with time in a known way).

When did you get interested in astronomy?

I think I was about 8 years old. I came to it through science fiction. When I started reading science fiction, I thought it was really cool stuff, and I started learning about space. My father was a physicist and he encouraged me, and I never lost my interest after that. However, I did do a career report in the 8th grade and decided that astronomy was too small and esoteric a field to be a realistic career. Later, I was majoring in physics at Stanford, and realized that I only wanted to do it if I could do it as astrophysics. So I just thought I'd go to grad school, and thought I'd see how long my astronomical career lasted.

You teach both elementary and advanced classes. How do you contrast them?

I have taught everything from basic astronomy students to grad students. I find that almost everybody has some interest in astronomy and I never have trouble conversing about astronomy at any level. I have enjoyed the introductory classes the most, because it is easy to amaze the students, and we show lots of great images. The grad courses go deep into math and physics, but we are teaching the students how to extract information from subtle signatures. It is amazing how humans can extend our minds deep into space in this way.

How exciting has astronomy been for you since you started your career?

It turned out to be a particularly good time to get into astronomy, just as I became a grad student. Space astronomy had just opened up. I was able, my last student year, to work with the International Ultraviolet Explorer (a small space telescope) to do hands-on, real-time observations. Also, computers have gotten better and better and better. And detectors have become far more sensitive and versatile.

It has been a particularly exciting time for the last 30 years or so, and I think that will be true for the next 30 years.

What excites you most about new planets being found: astronomical reasons or the idea that they are a possible location for life?

In the end, it is the question of life that is most exciting. I am also excited about the fact that we now have techniques that allow us to attack this question empirically. The radial-velocity method has been very successful for giant planets, but we are now discovering large numbers of super-Earth/mini-Neptune and Earth-sized planets by transits using the Kepler space telescope. We now know the number of terrestrial planets in our Galaxy is huge. This is a watershed in humans' understanding of our context in the Universe.

What do you think are some of the major discoveries that will be made in the next 20 years?

We are now discovering Earth-like planets. We have already made the first measurements of atmospheres on other planets, and hopefully we will be able to do this on planets that might be like ours. I think we will make major progress toward the question of life on Mars and Europa (and perhaps other Solar System locations like Titan). Cosmology will be tackling the questions of dark matter and dark energy, which are currently big unknowns about our Universe. We will understand the formation of galaxies in as much detail as we are now getting knowledge of star and planet formation. Very large ground-based telescopes will remove atmospheric blurring well, and from space we will measure parallaxes and motions of stars across our Galaxy, giving us a precise distance scale and a real understanding of dynamics in our Galaxy and beyond. Vast amounts of data at all wavelengths and with good time coverage will be available over the Web for many to analyze in new and different ways. And computer models of very complicated systems with very great resolution and physical detail will provide a new means of observing the cosmos.