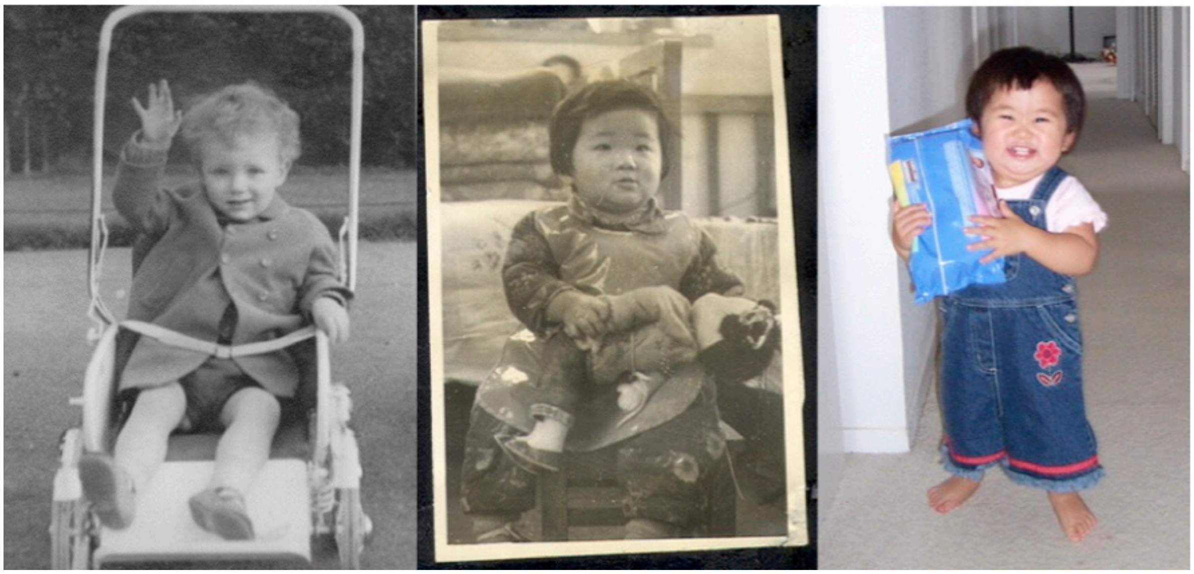
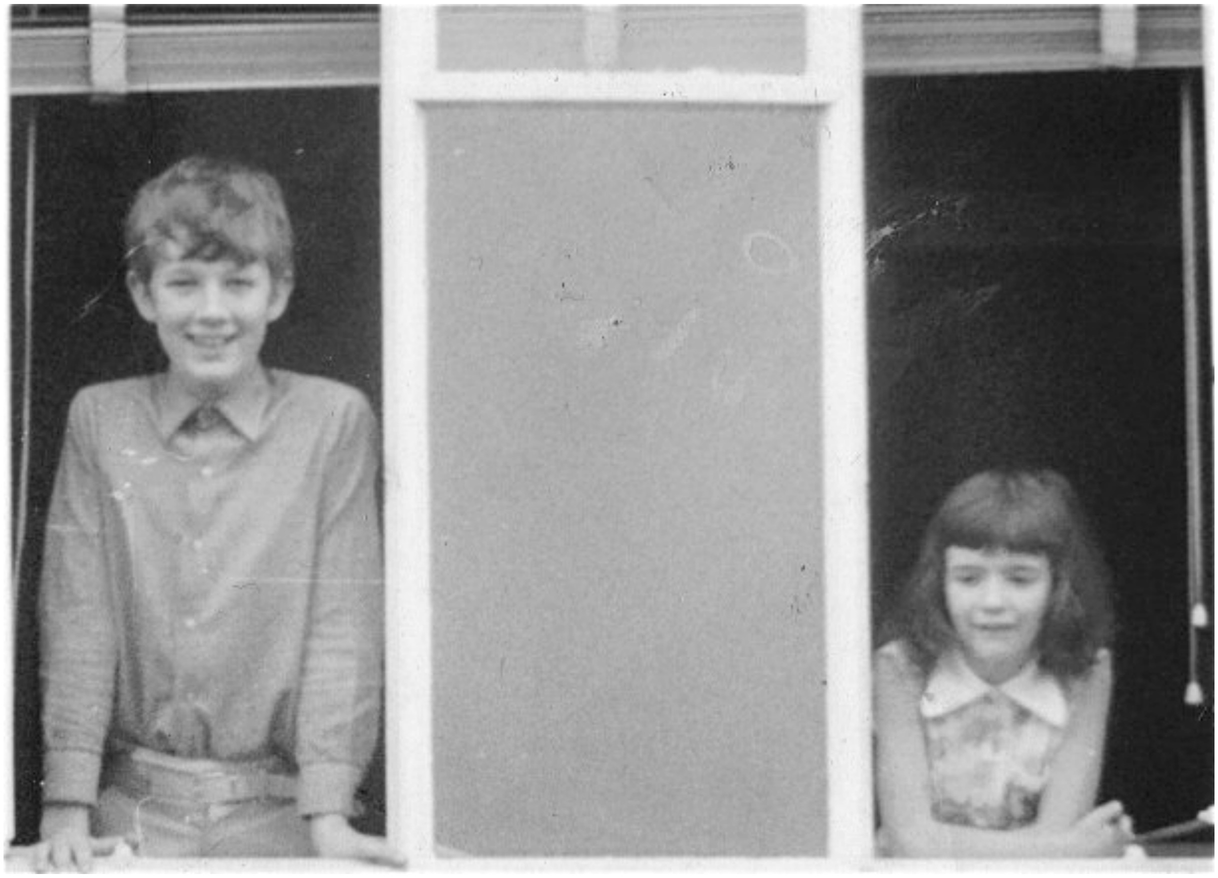
**Autobiography for the Shaw and Kavli Foundations**

I was born in north London in 1958. My father worked on a factory assembly line producing industrial steel cutters, my mother was a telephone operator. We lived with my grandmother, upstairs in a council house in Tottenham. My first memories are of a winter with very heavy snow (lots of fun), of having appendicitis (lots of pain) and of the birth of my sister, Jenny, all in 1962. We had no car, no phone, and the electricity meter had to be fed a steady supply of coins to keep the lights on. "Quick! Put another two shillings in the meter!", was a common shout.



Caption: The author in London, his wife Jing Li in Beijing and daughter Suu Suu in Honolulu, all aged two.

One evening in 1965 I noticed several bright meteors as they flashed overhead within a short interval. My mother said they were "shooting stars", which confused me (how can a star "shoot"?) and left me wondering what I had seen. Later, my grandparents bought me a 40 mm diameter table-top telescope as a birthday gift. Through it I saw the Moon, the stars and the planets, all against the sodium streetlight glare of the big city. I was astonished. A few years later, my uncle Malcolm built me a 150 mm telescope. The planets looked even better: I could see the rings of Saturn, the polar caps on Mars, I watched Jupiter rotate, and the Moon was simply fabulous. But I was also interested in trees, writing, machines, history, animals, music, rocks and fossils.



Caption: With my sister Jenny, in about 1967.

I was extremely fortunate. Both my parents were supportive and encouraged my interests where they could. The fact that they could not answer most of my questions was good for me, because I was forced to turn to books (weekly visits from my school's traveling library saved the day - we had very few books at home). That we didn't have much money led me to appreciate possessions, especially things that I could scavenge or make myself. And the state schools I went to, although rough by current standards, had enough really good teachers to keep me interested. NASA's focus on the Moon provided an inspiring, rolling backdrop to my early youth. Apollo 8, carrying the first people ever to orbit another celestial body, simply blew my ten-year-old mind. Apollo 11, the next year, unfolded like a dream.

When I was 12 or 13, I encountered "physics", then a new word for me. I found that it included many of the topics I most loved, including astronomy. A teacher told me that physics was the most difficult of subjects: I decided immediately to try to become good at it. Other teachers told me that human knowledge was so vast that nobody could ever hope to get to the edge of it: you just had to study what others had already done. For years I believed them.

Caption: My 10 inch telescope in the back garden, about 1974.

Nobody in my family had been to a university or knew how to get into one. Luckily, Britain then made higher education free to those who academically qualified, as I did. Without that national largess, I couldn't have gone to University College London (UCL), where I started in 1976. UCL gave me a strong grounding in physics, mathematics and astronomy for which I remain extremely grateful. My favorite subjects were thermodynamics, mathematics, and a broad physics course by one Professor Boyd. He covered everything from quarks and quantum mechanics to cosmology and he even included religion. Twenty years later I heard that Professor Boyd had been criticized by his colleagues for "teaching a course with little depth" but I greatly appreciated the sweeping perspective and I admired the way Boyd lectured very naturally, almost conversationally, with few written notes.

Prof. Mike Dworetsky at UCL suggested that I apply to the California Institute of Technology (Caltech), a far-away place I had never heard of. Somehow, I found that Caltech was related to the famous Palomar Observatory and to Jet Propulsion Laboratory, both of which I knew about, and so I applied. I moved to Pasadena in 1979. Compared with UCL, few of the classes offered at Caltech held much interest for me. But Caltech emphasized research, and I took to that like a duck to water. With the always enthusiastic JPL manager/engineer Ed Danielson, I became a frequent user of Palomar Observatory. We made every conceivable mistake, wasting truly vast amounts of observing time and endangering equipment and life in ways that now make me shudder. Of course, this was the best possible training in observational astronomy I could have received. Over time, I began to write papers based on my Palomar data, at first about planetary nebulae, then about comets. These two topics grew to become my PhD thesis. Jim Westphal, a broad-minded experimentalist with a refreshingly non-traditional background, was my PhD advisor. I worked much more with Gerry Neugebauer, indefatigable leader of the Infrared Army.


Caption: Official press photo with Ed Danielson taken for the recovery of Comet Halley in 1982. Then, as now, Caltech was very good with public relations.

A visit to Caltech by Greek composer Iannis Xenakis left a very strong memory. I had known of Xenakis for years, and was thrilled to see him and the large reel-to-reel tape machine which he used to play sound samples. In previous lives, Xenakis had fought in the resistance against Germany, had been shot in the face by a British tank and sentenced to death by his own government. He was also an architect and a mathematician. Xenakis invented his own musical notation: a Xenakis score looks like a dense doodle made by dragging a handful of pens over a sheet of paper. I was so impressed that one person could embody so many different past lives and do so many interesting things. And I was surprised that, in a university of several thousand people, only about 20 could be bothered to come to see this world-class individual. Xenakis was definitely brilliant. In the strange compression of memory, his talk, lasting perhaps an hour and a half, leaves a bigger imprint than almost any other event in my four years in Pasadena.

I moved to the Massachusetts Institute of Technology (MIT) in Boston in 1983 as an assistant professor. The change in environment was good for me, but MIT did not then have access to the best telescopes, and the step down from Palomar was painful. Worse, the door to Palomar soon slammed shut and, indeed, I have not been back, except as a tourist. My transition from graduate student to professor was brutal. For example, I didn't know how to teach and nobody offered advice. My NASA proposals were serially rejected. There were very few people to talk to. I knew nothing of academic politics. But in research, I became more and more interested in the nature of comets because of their promise as pristine relics from the earliest days of the solar system. I wrote a number of papers trying to set their study on a more quantitative basis than had yet been done. I still like those papers. Later I found that the sizes, shapes and rotations of the cometary nuclei, far from being pristine, are highly evolved.

MIT was where I first wondered "why is the outer solar system so empty compared to the inner solar system?", the key question that later unlocked the door to the Kuiper belt. In 1986, first-year graduate student Jane Luu asked me if I had a short-term project on which she could work. Soon after, we started the "slow moving object" (SMO) survey aiming to detect, or set limits to, any objects beyond Saturn. Using MIT's 1.3 meter telescope on Kitt Peak in Arizona, the electronic portion of this survey used a camera having 240 x 280 useful pixels. We found nothing beyond Saturn. We couldn't know that this modest telescope and tiny camera were far too small to unveil the trans-Neptunian region.

My move in 1988 to the University of Hawaii gave me access to all the telescopes on Mauna Kea. This vast volcanic mountain is far better for astronomy than either Palomar or Kitt Peak because its altitude and Pacific location place it above the densest, wettest, most turbulent portion of the atmosphere. While conducting other science projects, I continued the SMO survey with Jane whenever possible. It was easy to find main-belt asteroids interior to Jupiter but, again and again, we detected nothing at larger distances. With planetary astronomy then at the bottom of the astronomical barrel, the Hawaii telescope time allocation committee soon grew tired of my requests for more observing time. So, under false but necessary pretenses, I obtained time for other projects and then used it for the survey. Similarly, NASA rejected my proposals to fund the work, so I diverted money allocated for other purposes to maintain the SMO survey, possibly illegally. This went on for years.

Caption: At the University of Hawaii 88-inch telescope, 14,000 ft above sea level on Mauna Kea, Hawaii.

The decade of the 1990s was especially full of surprises, both personal and scientific. While observing on Mauna Kea in 1991, I met Jing Li, a Chinese graduate student in solar physics from the University of Paris. Jing was visiting Hawaii to use the Canada-France-Hawaii Telescope to try to measure magnetic fields in T-Tauri stars. After many trips back and forth between Honolulu and Paris, we were married in 1993. Our daughter, Suu Suu, was born in 2000.

In August 1992 Jane and I finally detected the first object in the outer solar system, 1992 QB1, using a 2048 x 2048 pixel camera at the UH 88-inch telescope. It orbits at 44 AU and is about 250 km in diameter. Once we had found the first one, finding more was easy. Six months later we added the second object and then promptly we discovered dozens more. These are collectively known as trans-Neptunian or Kuiper belt objects (the name is unfortunate, in that Kuiper had no quantitative model and even anti-predicted the belt by specifically asserting that the region where we found objects would be empty).

Caption: The author with instrument scientist Kentaro Aoki (red) measuring the infrared spectrum of Kuiper belt object 1996 TL66 at the Subaru telescope on Mauna Kea.

The year 1992 marked the beginning of an intense period in which almost everything we did produced a discovery, starting with the mapping of Kuiper belt structure. We found that the belt is thick, more like a doughnut than a sheet of paper, providing evidence of an unexpectedly violent past. We discovered the Classical Kuiper belt, the Neptune-resonant populations and, in 1997, the Scattered Kuiper belt objects. The latter are the long-sought source of short-period comets (and so, ironically, the ultimate source of the meteors that caught my eye as a child). University of Arizona theorist Renu Malhotra showed that the resonant KBOs imply that Neptune had migrated outwards. Recognition of Neptune's migration is one of the most important consequences of the Kuiper belt, leading to an entirely new and rather chaotic view of solar system evolution. We established in 1995 that Pluto is best understood not as a planet, but as a bright Kuiper belt object. This subject was rehashed a decade later in a public debate driven by Mike Brown. We found that the colors of Kuiper belt objects are more diverse than any other populations in the solar system, a fact for which there is still no convincing explanation. Joined by graduate student Chad Trujillo, we measured the mass of the belt and found too little material for the observed objects to grow - the current belt is probably a remnant of an original structure that was hundreds of times more massive. With another student Scott Sheppard, I obtained new measurements of the physical properties of Kuiper belt objects, finding some that are very elongated and of such low density that they must be internally porous. Few of our observational results were predicted but they have spawned increasingly elaborate models that paint a picture of the solar system quite different from anything described before.

While the first decade in the Kuiper belt was a decade of discovery, as time passed I began to feel that we had reached a point of diminishing returns. The observational pace slowed even as other workers began to enter the field. With notable exceptions, the second decade of the Kuiper belt has been marked more by methodical, detailed investigations which, while valuable, have not materially changed the basic picture we established from comparatively limited data in the first decade. I find that I am neither particularly interested in this type of detailed measurement nor especially good at it (perhaps these two things are connected!). I prefer to work in an uncharted place where little or nothing is known and where nobody else is working.

Caption: Posing with Jing, Suu Suu and silly hats in 2010.

We moved to the University of California at Los Angeles (UCLA) in 2009. Here I continue to explore the solar system using telescopes on the ground and in space while Jing works on the Sun. Most of the objects I study - the comets, the Centaurs, Trojans, irregular satellites, the asteroids - were formerly seen as members of discrete and disconnected populations. Now, we know that most either escaped recently from the Kuiper belt or could have done so in the distant past. It is very satisfying to think that the Kuiper belt provides the umbrella connecting all these populations.

Occasionally, the good young people of California ask me for my thoughts about a career in science. I tell them that "career" is for car salesmen, doctors and corporate executives, not for me. Astronomy is an obsession, not a career. And they ask how best to do research in astronomy, as though I am some sort of an expert. But I am not. Everything I do, no matter how simple, feels to me like a new thing for which I am unprepared and which I know I will get wrong many times before I get it right. "Success is the ability to go from one failure to another with no loss of enthusiasm", Churchill brilliantly observed. If I have any strategy at all, it is, first, do whatever seems interesting and, second, stop doing it when the interest wanes. Then repeat.

--David Jewitt
UCLA, August 2012