Ali Javan

1926–2016

BIOGRAPHICAL *Memoirs*

A Biographical Memoir by
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NATIONAL ACADEMY OF SCIENCES

ALI **JAVAN**

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A. Javan

By Robert J. Scully and Marlan O. Scully

Ali Javan was born in Tehran, Iran, the son of Azerbaijanis from the city of Tabriz in the country's northwest. His father was a lawyer who had attended what were then considered the great political school and law school of Tehran, and his mother was an artist. Ali attended a Zoroastrian high school from the 7th through 11th grades and graduated from Alborz high school, a prep school ranking among the world's finest. Originally founded as an elementary school by American missionaries, it compares to the Milton Academy in the United States, producing many of Iran's future leaders and scientists. Upon graduation, Ali studied science for a year at the University of Tehran.

Ali relocated to New York in 1948, where he met Charles Townes. Ali used to tell the story of walking into the Columbia physics department office, explaining that he was fluent in French, and wanted to talk to someone about studying physics at Columbia. They sent him to Townes because they knew he spoke French. But as Ali recalled with a chuckle, they ended up speaking English because his English was better than Townes's French. In any case, Ali was accepted into Columbia University, where he earned a Ph.D. with Townes without having received a master's or bachelor's degree.

Javan's graduate studies took place during exciting years in physics, especially at Columbia. Molecular energy states, the vacuum-polarization effect, inverted energy states, and other discoveries were just being made; and a whole new world of innovations, such as masers and lasers, with profound application to fields such as communication and medicine, were occurring. Working with Townes as his thesis advisor, Javan helped to develop an atomic clock and the molecular oscillator (from which Townes's maser would soon come to fruition) and he used the microwave atom-beam spectrometer in the study

of atomic structure. Nobel Prize winner Willis Lamb also worked at Columbia, where he did the Lamb Shift experiments that kick-started quantum electrodynamics. It was during these heady times that Javan received his doctoral degree in 1954.

Herriett, Javan, and Bennett experimenting with He Ne laser. (1961)

Ali went to work for Bell Telephone Laboratories in 1958, and he found a very positive environment there. Consistent with the tradition begun by Alexander Graham Bell when he created Bell Labs, the management was helpful and encouraging; and everyone, even a president or distinguished senior scientist, was called by his or her first name. Most important, the research being conducted there, in state-of-the-art facilities, was exciting.

Javan pursued various projects at Bell Labs, but he devoted much of his time to producing the helium-neon laser. Working in conjunction with Donald Herriott and William Bennett in the early 1960s, they produced the first manifestation of continuous-wave lasers, which have many interesting applications and to this day remain workhorses in laser physics.

Ali's most memorable breakthrough came one afternoon in 1960, when a snowstorm had forced a closure of the lab. There Javan viewed for the first time the laser's beautiful red beam of light, which was as pure as permissible by the laws of nature. The next day, he and his colleagues scored another first when they used the beam to place a telephone call. Javan and Bennett patented the soon-to-be-mass-produced helium-neon laser, which they called a "gas optical maser." This technology later found widespread use in industrial and scientific venues and in everyday applications such as videodisk players, UPC scanners, welding, holography, Internet data transmissions, and medical procedures.

In 1961, Javan was appointed associate professor of physics at the Massachusetts Institute of Technology (MIT), where he founded a full-scale research lab for the development of laser technology. He also established the field of laser spectroscopy using high resolution. He and his group were prolific, implementing many new advances such as the unlocking of many of the secrets of laser/matter interactions, aka the light/matter interaction.

Javan's work also aided in the development of semiconductors and deepened scientists' knowledge of the properties of heating, melting, absorption, cooling, and solidification of material in a nonexcited state.

The benefits of working with Javan were not only scientific. MIT students and his younger MIT associates—including one of the authors—remember him as being inspiring and kind. He valued friendships very deeply, and he treated his students like family.

Ali Javan awarded Albert Einstein World medal of Science for his pioneering laser research. (1993)

Willis Lamb presents the PQE Lamb medal for laser science to Ali Javan.

Ali had a long and distinguished career at MIT, during which time he received many honors, starting with his appointment as the first Francis Wright Davis Professor of Physics at MIT. He held this position from 1978 through 1996, and thereafter became emeritus professor of physics. Other awards included the Albert Einstein World Medal of Science of the World Cultural Council Foundation, induction into the National Inventors Hall of Fame, appointment as a fellow of the American Academy of Arts and Sciences, and election to the National Academy of Sciences. He was also an honorary associate fellow of the Trieste Foundation for Advancement of Freedom in Sciences and an honorary associate fellow of the Third World Academy of Sciences. If he had a favorite honor, perhaps this latter one was it, as he so often spoke of it when interviewed.

Another award that Javan especially cherished was the Lamb Medal for Laser Physics presented at the Physics and Quantum Electronics conference in Snowbird, Utah. This award (see photo above) was especially meaningful to Javan because of his close relationship with Willis Lamb.

For example, Lamb had predicted that the gain vs. detuning curve for the He-Ne gas laser should be at its minimum when the laser radiation is resonant with the atoms, and he and Javan had a productive discussion on this phenomenon, now called the Lamb dip, while stuck in New York traffic one evening. They recalled that they were enjoying the discussion so much, they did not realize they were stuck until the next day, when the newspapers reported on the massive jam caused by a failure of traffic lights.

Ali was introduced to Marjorie, his future wife, by his physician, whose daughter was Marjorie's friend. The Javans later joked that theirs was an arranged marriage. Regardless, they had a happy marriage that produced two daughters, Mia and Lila. Ali was a loving and supportive father who, for example, would take his daughter's whole kindergarten class to his labs, where graduate students would play with the kids and teach them a little science.

Ali Javan with his wife Marjorie and daughter Mai-Azar. (1966)

The Javan family made a few trips to Iran. Marjorie's first visit to the country occurred when she accompanied Ali to a spectroscopy conference in Isfahan, which she discovered was a magical Eastern city full of history and magnificent mosques. During that trip she became acquainted with Ali's mother (his father had passed away a few years earlier).

Marjorie described Ali as "well rounded, charismatic, musical, and absolutely unique." Indeed, he had a strong interest in the humanities, and took many courses in literature and music. He was always finding a connection between the arts and the sciences, He once wrote, "In physics and music you find the same spirit; it just manifests itself in different directions. There's something immensely beautiful about physics, even though it's very difficult. Take the atom—a single atom is

absolutely gorgeous." Javan also derived extra benefits from his love of music: he taught himself German by listening to Mozart's *The Magic Flute*.

Ali died in Los Angeles on September 12, 2016. In his last days, he listened virtually nonstop to his favorite composers, Mozart and Mahler. He was surrounded by family and friends, many of whom read to him from physics journals. His daughter Lila said that he spent this time "very peacefully."

We conclude with a poem written for Ali on the occasion of the 50th anniversary of the Ne He laser:

To the East we owe so much:

Algebra, art, alfalfa, and such.

And to that list we surely must add,

This Columbia walk-in, a brilliant young lad,

Appearing one day, clear French he did speak

So Prof. Townes they sent him to seek.

It was a time when giants walked the Earth,

And Columbia, oh Columbia, to Javan gave birth.

'Twas there the maser Townes did push

Ignoring the jibing of Rabi and Kush.

And out of that cauldron comes our young Persian,

Of molecules and masers—Total Immersion.

Well did he master the theory of masers,

Knew how to handle quantum-state phasors.

Early foresaw masers without inversion,

But on to gas lasers, no time for diversion.

The way was rocky—road not clear

But bravely he struggled encouraged by Kastler.

Eureka, said he. "Neon's a good sign,"

Just mix it with helium and let the light shine,

Thus causing the atoms with Rabi to flip,

And thanks to Herr Doppler, a pretty Lamb Dip.

In Doppler's profile many holes he did burn,

Gleaning new physics-and much he did learn.

There's fat holes and thin holes, herald Feld and Javan,

To spectra and lasers a new era did dawn.

From Bioscience to Astronomy,

A shiny new toy is the "HeeNee."

Of medals and kudos he got the works,

From Ballentine and Ives to his Fanny Hertz.

So the clan has gathered—Texas, Japan, and the USA,

Just to admire you, Ali, on this fun day.

From all of us, Ali,

Thanks for being you!

Marlan Scully 12/12/2010

(50 years of the He Ne laser)

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