OBITUARY

Jacob Israelachvili (1944–2018)

Professor Jacob Israelachvili was a paragon of colloid and interface science.

He devised world-leading experimental methods to measure the physical forces acting between surfaces in close proximity. These surface forces determine the behaviour of a collection of particles or objects, and they are important in many areas of nanotechnology, colloid science, tribology, biophysics and materials science. Israelachvili's key achievement was to design and build a device, the surface forces apparatus (SFA), capable of measuring these forces in a variety of systems. A kind, witty and charismatic person, he won the respect and the affection of his many students, postdocs and colleagues over a career spanning almost five decades.

While his many successes with the SFA can be attributed to a rare combination of physical insight and great skill as an experimentalist, Israelachvili also liked to develop theoretical models, and one of his most important contributions was in the area of membrane biophysics when in 1976 he conceived the idea of a simple parameter based on the geometry of surface active molecules, later called the 'surfactant packing parameter'. This allows prediction of the type of surfactant aggregate (micelle, vesicle, bilayer membrane and so on) that molecules can form. In 1985, the first edition of his book *Intermolecular and Surface Forces* was published. With its succinct and accessible style, this text (now in its third edition) has become a standard reference for students and researchers in many areas of materials science and engineering.

Born on 19 August 1944 in Israel, Israelachvili died on 20 September 2018 in Santa Barbara, California. He studied physics at the University of Cambridge, first as an undergraduate and then for his PhD with Professor David Tabor (whose gentle, inclusive and egalitarian style of supervision he inherited). Tabor's lab had been developing methods to measure forces acting between molecularly smooth mica surfaces. A finely developed form of optical interferometry was adapted to measure the separation between two mica surfaces with an accuracy of 0.1–0.2 nm. Israelachvili made further refinements of the experimental methods, leading to a landmark paper in 1972 on the measurement of van der Waals forces in air and vacuum.

After a period at the Karolinska Institute in Stockholm, where he embarked on

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research in membrane biophysics, he was brought back to surface force measurements by Professor Barry Ninham of the Australian National University in Canberra. Ninham, a mathematical physicist, wanted to conduct experimental work to measure the forces that he and his colleagues studied theoretically. Advised that Israelachvili was the best person for the job, he duly recruited him in 1974.

Within two years, Israelachvili had built an SFA that could be filled with liquids, greatly extending the suite of forces that could be measured. His first experiments confirmed the foundations of the classical DLVO theory of colloid stability, and later ones explored its limitations when other forces come into play. Over the next decade, he and his colleagues produced a series of landmark papers showing how surface chemistry and the properties of a liquid or vapour medium determine inter-surface and particle interactions.

In 1986, he moved to the University of California at Santa Barbara. His group was at the forefront of research on the interactions of biological and biomimetic model surfaces across aqueous solutions, underwater adhesives derived from or inspired by mussel foot proteins, and the adhesion mechanism of gecko toes to different types of surfaces. Another area of research, sustained throughout his career, was the elusive origin of hydrophobic forces.

He was also one of the pioneers of the field now called nanotribology. His work on friction and lubrication informed modelling studies by others and led to insights on the stick-slip phenomenon and the relationships between adhesion and friction.

Jacob (as everyone knew him) was an outstanding adviser to his research group and to many others who sought out his company and insights. He took the time to provide the individualized advice and support each person needed, an approach that was viewed with some envy by members of other research groups (and occasional scepticism by their advisers). All data were examined with kind interest, possible sources of mistakes were patiently discussed, new and improved experiments were suggested, and any frustration he may have felt was concealed well. Having designed the instruments himself, he was also the expert on their use. On occasions when he was called in to troubleshoot some particularly problematic experiment, he would quietly inspect the set-up for some time, and then provide a diagnosis, often prefaced with a smile and "You know, I saw that problem once before..." With his gentle approach, he inspired and motivated more than 70 graduate students and postdocs, about 30 of whom have become faculty, and more than one-third of the latter are women.

Always interested in the history and development of scientific thought, Jacob had anecdotes about scientists from every era. His scintillating wit made him an entertaining speaker, and a wonderful companion at any social gathering. Those who worked with him will remember his eternally optimistic mantra, "If it can possibly go right, it will" — the very antithesis of Murphy's Law — and how surprisingly often the experiments that he tried did go right. Many people around the world have happy memories of their interactions with him. He will be deeply missed. □

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