The key to ion beams' polarisability

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Polarisability determines the force with which an inhomogeneous external electric field acts on the ions of an ion beam. However, it can be quite tricky to obtain accurate values for this force. Now, two German theoretical chemists, Volker Koch from Bielefeld University and Dirk Andrae from the Free University Berlin, have devised formulas providing the polarisability of atomic ions as a function of their total charge number. Their findings, about to be published in EPJ D, have implications for many applications, ranging from the use of ion beams for research purposes or as a source for dopant atoms in semiconductor manufacturing to the modelling of planetary and stellar atmospheres.

Being a characteristic quantity of an atom's or ion's electronic state, the polarisability of atoms or ions with several electrons had been difficult to obtain to date because simple equations for it were not available. Most previous theoretical studies of polarisability focused on individual atoms, or early members of series with a constant number of electrons, so called isoelectronic sequences. The electron numbers were usually small, and closed-form expression for the polarisability was never provided. A single exception to this situation were the formulae related to the so-called Stark effect in hydrogen-like atoms derived by Austrian physicist Erwin Schrödinger and Russian-American physicist Paul Epstein, back in 1926.

In their study, the authors used a numerical method to calculate the energy of atoms and ions of a given isoelectronic sequence under various strengths of an external electric field. This numerical approach makes it possible to derive the polarisability of atoms with small to large electron numbers using conventional techniques of numerical analysis.

Koch and Andrae thus established a rational function for each isoelectronic sequence to represent the polarisability data previously established with the numerical method. In addition to generalising previous findings made on hydrogen-like atoms, this research also provides a reference for future use.

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