Dynamic polarizabilities for the low lying states of Ca^+

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Synopsis The dynamic polarizabilities of the $4s$, $3d$ and $4p$ states of Ca^+, are calculated using a relativistic structure model. The wavelengths at which the Stark shifts between different pairs of transitions are zero are calculated. Experimental determination of the magic wavelengths could prove useful in developing better atomic structure models and in particular lead to improved values of the polarizabilities for the $Ca^+(3d)$ states.

The dynamic polarizability of an atom or ion gives a measure of the energy shift of the atom or ion when immersed in an electromagnetic field [1]. The calculations of dynamic polarizabilities can be used to identify magic wavelength of atomic transition states and tune-out wavelength of atomic states [2, 3, 4], at which polarizability related quantities are equal to zero. Therefore they do not rely on a precise determination of the strength of a static electric field or the intensity of a laser field. This makes it possible to determine the magic and tune-out wavelengths to a high degree of precision [5].

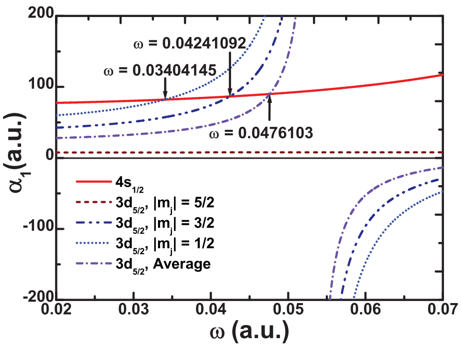

Figure 1. Dynamic polarizabilities of the $4s_{1/2}$ and $3d_{5/2}$ states of Ca^+ with the photon energy in the range of 0.02 to 0.07 a.u. Magic wavelengths are identified by arrows.

In present work, we calculated the dynamic polarizabilities of $4s$, $4p$ and $3d$ for Ca^+ using a relativistic structure model method [6]. A number of magic wavelengths of $4s - 4p_{1/2,3/2}$ and $4s - 3d_{3/2,5/2}$ transition states are also identified. The results of $4s - 3d_{5/2}$ are given in Figure 1 and Figure 2. Detailed results will be presented in the conference.

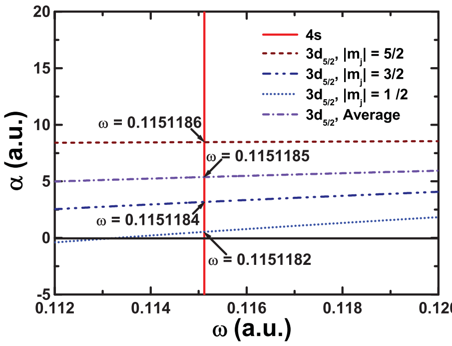

Figure 2. Dynamic polarizabilities of the $4s_{1/2}$ and $3d_{5/2}$ states of Ca^+ with the photon energy in the range of 1.12 to 1.2 a.u. Magic wavelengths are identified by arrows.

Experimental determination of these magic wavelengths can be used to determine reasonably accurate estimates of the ratio of $f_{3d_J \to 4p_{J'}}$ and $f_{4s \to 4p_{J'}}$ oscillator strengths . This could prove valuable in developing better atomic structure models and in particular lead to improved values of the polarizabilities needed in the evaluation of the black-body radiation shift of the Ca^+ ion.

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