Orbit-space weight functions for two-step gamma-ray emission spectroscopy

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We present calculations of the orbit-space sensitivity of two-step reaction gamma-ray spectroscopy diagnostics [1, 2], with arbitrary line-of-sight in toroidally symmetric magnetic equilibria. We consider the two-step reaction between alpha particles and beryllium-9 [3], generating a neutron and an excited carbon-12, the latter of which then decays emitting an MeV photon. We show how the kinematics of this process influences the diagnostic sensitivity, and how this relates to experimentally obtained spectra [4]. Each synthetic spectrum is calculated orbit-wise, and each orbit, in a toroidally symmetric tokamak, is described via the triplet of energy E, maximum major radius R_m and pitch value at that maximum major radius $p_\mathrm{m} = (v_\parallel/v)_\mathrm{m}$; orbit trajectories are computed via the OWCF code [5]. Given the high dimensionality of the task [6], we also show how neglecting the velocity of the thermal beryllium leads to an analytical solution [7, 8] that well approximates the same results and requires less computational power, i.e. an alternative route to standard Monte Carlo methods [9].

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