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**Systematics of nondipole effects on photoelectron angular distributions for 3s and 4s photoionization in the region of quadrupole Cooper minima**[1] L.A. LAJOHN, R.H. PRATT, University of Pittsburgh, S.T. MANSON, Georgia State University — Dipole effects are dominant in low energy photoeffect integrated cross sections, but quadrupole effects on differential cross sections (DCS) can be quite substantial, due to the presence of dipole-quadrupole interferences terms in the angular distribution parameters $\gamma$ and $\delta$. At low photon energies, quadrupole effects are seen in the parameter $\gamma$, dependent on dipole and quadrupole matrix elements and the cosines of phase shift differences. Calculations have been performed over a broad range of Z and a number of Cooper minima in $3s \rightarrow \epsilon d$ and $4s \rightarrow \epsilon d$ quadrupole transitions have been found for photon energies below 100 eV. The locus of these quadrupole matrix zeros (QMZ) have been mapped out; they appear above the ionization threshold for Z's of 11-30 for 3s and 19-50 for 4s. The nondipole photoelectron angular distribution parameter $\gamma$ has been calculated for these Z's, and significant variations, as a function of photon energy, have been found. In particular, $\gamma = 0$ at the location of the QMZ, and also is zero where the cosine of the p-d phase shift difference vanishes. On the other hand, $\gamma$ has a maximum in the vicinity of dipole Cooper minima. The combined effects of these three types of zeros create the pattern of variations of $\gamma$ as a function of energy and Z.

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