Non-dipole Effects in the Photoionization of Xenon

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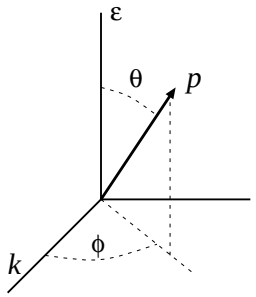
Abstract

Some new and interesting features in the non-dipole angular distribution parameters for the photoionization of xenon are described.

Outline

- ⋆ Angular Distribution
- ⋆ Independent-Particle Approximation - Correlation
- ⋆ Low-Energy Predictions
- ⋆ Shape Resonances

Angular Distribution



Dipole Approximation: $\mathcal{O}(1)$

$$\frac{d\sigma}{d\Omega}(\theta,\phi) = \frac{\sigma}{4\pi}\left[1 + \beta\, P_2(\cos\theta)\right]$$

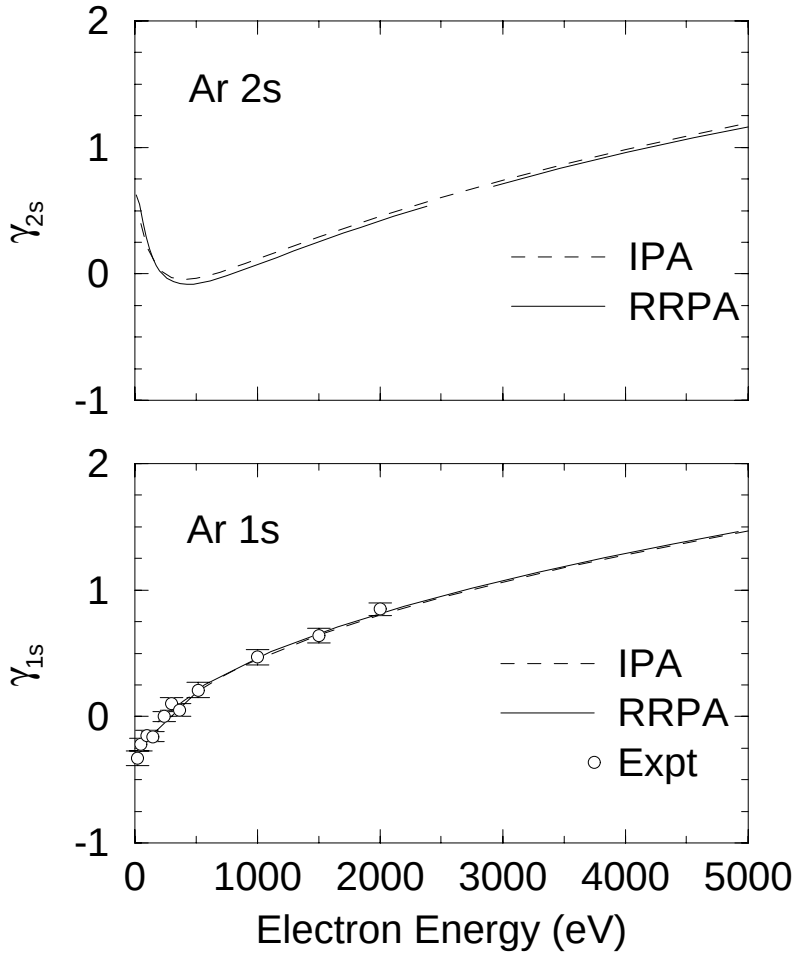
Electric Quadrupole correction: $\mathcal{O}(ka)$

$$+\frac{\sigma}{4\pi}\left[\left(\delta + \gamma\cos^2\theta\right)\,\sin\theta\cos\phi\right]$$

Calculations

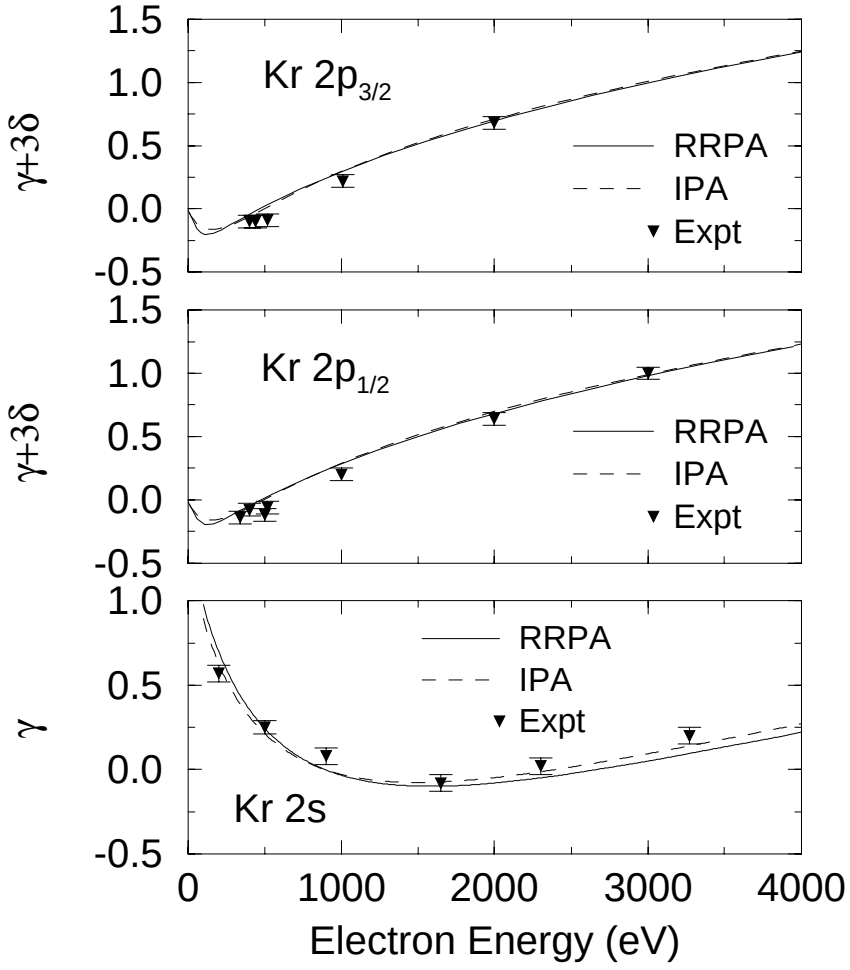
$$
\begin{aligned}
\beta &= \frac{1}{\bar{\sigma}} \sum_{\kappa\kappa'} \sqrt{30}\, \langle \kappa' || C_2 || \kappa \rangle\, (-1)^{j'+j_b} \left\{ \begin{array}{ccc} 1 & 1 & 2 \\ j' & j & j_b \end{array} \right\} \Re[\mathcal{D}_\kappa \mathcal{D}^*_{\kappa'}] \\
\gamma &= -\frac{k}{\bar{\sigma}} \sum_{\kappa\kappa'} \sqrt{105}\, \langle \kappa' || C_3 || \kappa \rangle\, (-1)^{j'+j_b} \left\{ \begin{array}{ccc} 1 & 2 & 3 \\ j' & j & j_b \end{array} \right\} \Im[\mathcal{D}_\kappa \mathcal{Q}^*_{\kappa'}] \\
\bar{\sigma} &= \sum_{\kappa} |\mathcal{D}_\kappa|^2
\end{aligned}
$$

Experiments-Argon

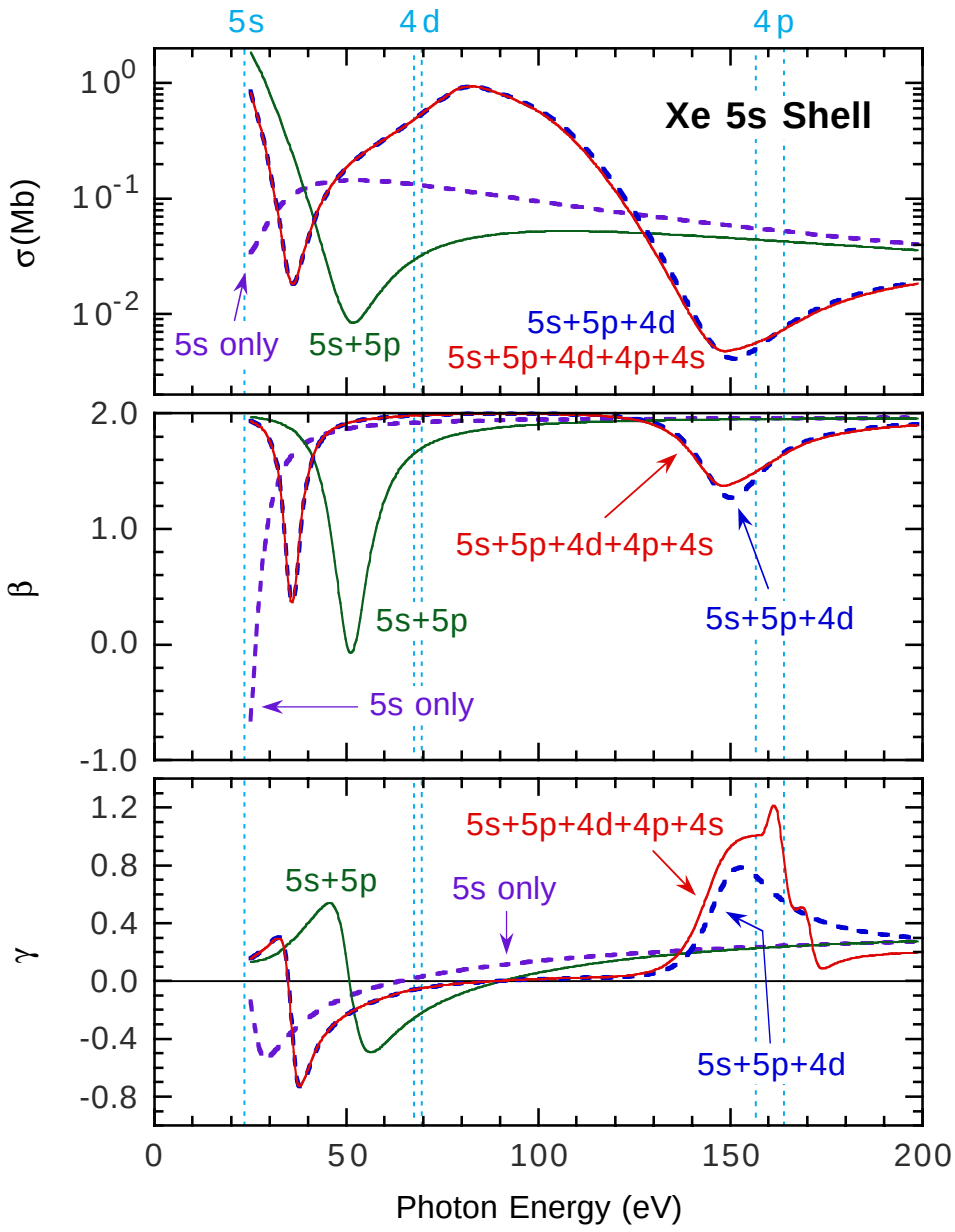


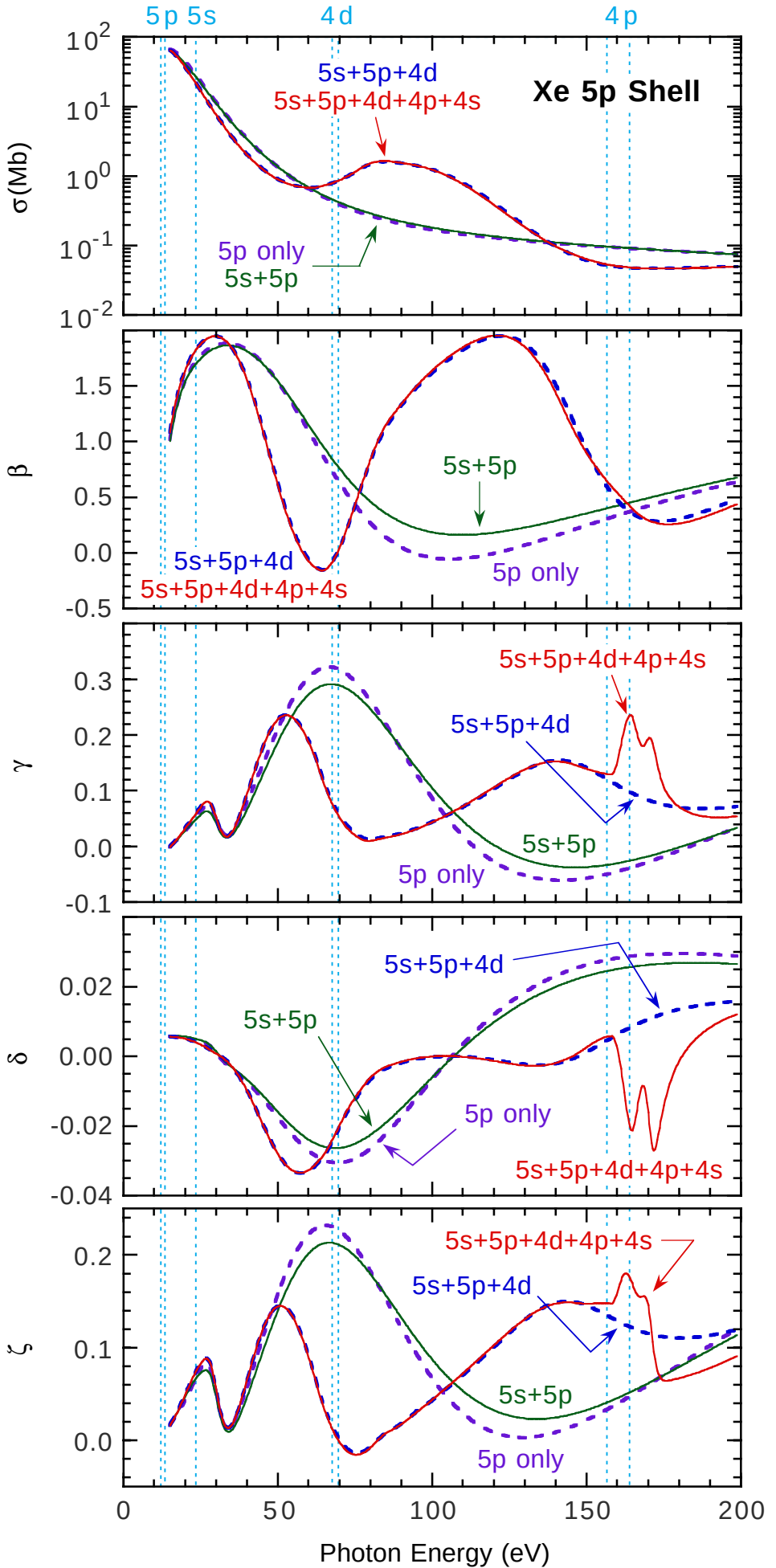
Expt: B. Krässig *et al.* Phys. Rev. Lett. **75**, 4736 (1995).

Experiments-Krypton



Expt: M. Jung *et al.* Phys. Rev. A**54**, 2127 (1996).


5s
4d
4p
Xe 5s Shell
σ(Mb)
10^0
10^-1
10^-2
5s only
5s+5p
5s+5p+4d
5s+5p+4d+4p+4s
β
2.0
1.0
0.0
-1.0
5s+5p+4d+4p+4s
5s+5p
5s+5p+4d
5s only
γ
1.2
0.8
0.4
0.0
-0.4
-0.8
5s+5p+4d+4p+4s
5s+5p
5s only
5s+5p+4d
0
50
100
150
200
Photon Energy (eV)


5p 5s
4d
4p
Xe 5p Shell
σ(Mb)
5s+5p+4d
5s+5p+4d+4p+4s
5p only
5s+5p
β
γ
δ
ζ
Photon Energy (eV)

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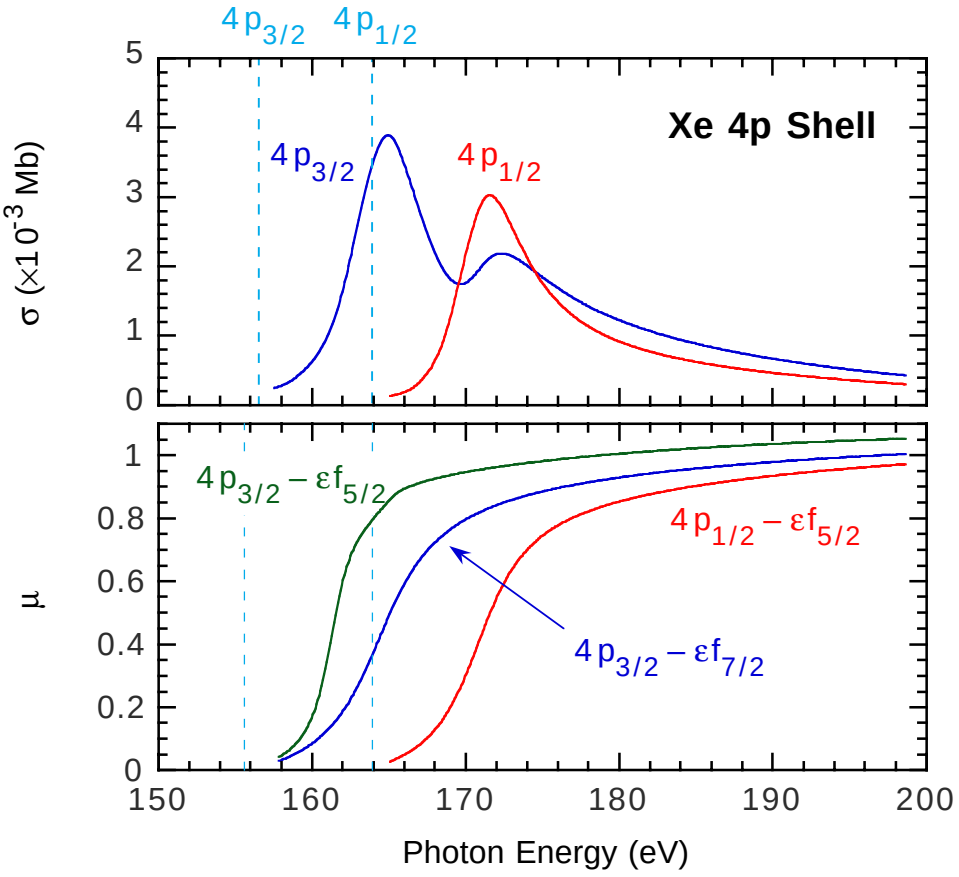
4p-f shape resonances



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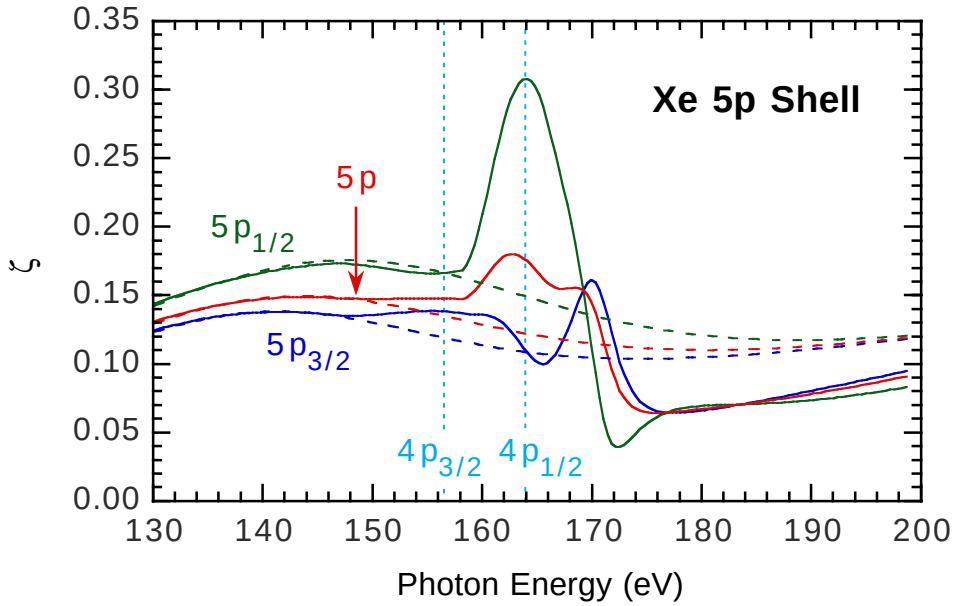
Resonant Region



Summary

- The non-dipole parameter γ_{5s} reaches a minimum value -0.8 near 40 eV. Rapid variation of γ_{5s} is also found near the second minimum of the $5s$ cross section at 150 eV, where γ_{5s} reaches a maximum value 1.

- Significant, non-dipole effects are also found in ζ_{5p} for the $5p$ subshell, which has a maximum value 0.2 near 50 eV, and a second maximum value 0.2 near 160 eV.

- The higher energy maxima are associated with a shape resonance in the $4p \rightarrow f$ [J=2] photoionization amplitude.

- The variations in the non-dipole parameters at higher energies are correlation effects not seen in IPA calculations.