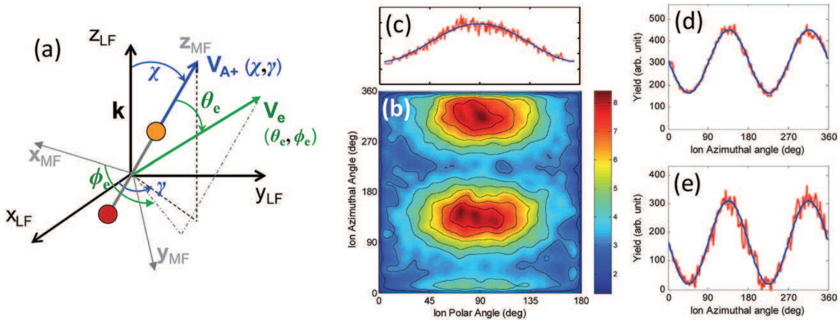

Fig. 1 (a) Schematic of the relevant angles: (θ_e,ϕ_e) represent the polar and azimuthal electron emission direction in the molecular frame (MF) and (χ,γ) the polar and azimuthal ion fragment emission direction in the laboratory frame (LF). (b) Bidimensional histogram of the (N^+, e) events showing the ion fragment polar and azimuthal dependences, for the studied polarization state S at $h\nu = 23.65$ eV; the 1D plots show: (c) the (χ) dependence, (d) and (e) the (γ) dependences according to eqn (4) plotted here as a function of $(\gamma + \pi/2)$, providing two determinations of the normalized s_1, s_2 Stokes parameters, *i.e.*, the polarization ellipse orientation angle (ψ) (see Fig. 2). The example shown leads to $s_1 = -0.05 \pm 0.01$ and $s_2 = -0.87 \pm 0.01$ corresponding to an orientation $\psi = 133.2° \pm 0.3°$.

propagation axis of the ionizing light, where x_{LF} is the reference axis in the polarization plane for the (γ) azimuthal dependence. In the MF, z_{MF}, parallel to the ion fragment recoil velocity, *i.e.*, along the molecular axis in the axial recoil approximation, and x_{MF}, a unitary vector in the plane containing z_{LF} and z_{MF}, are the reference axes for the (θ_e) and (ϕ_e) polar and azimuthal dependences, respectively. The MP method relies, on the one hand, on the strong dependence of the MFPADs induced by linearly polarized light upon the molecular axis orientation relative to the light polarization axis, and, on the other hand, on the circular dichroism in the MF frame[51] which reflects the different responses of the system when exposed to left (LHC) and right handed circularly (RHC) polarized light, respectively. When PI is induced by elliptically polarized light described by the three Stokes parameters s_1, s_2, s_3, defined in the LF,[1] this information is encapsulated in the following analytical form:[11,46]

$$\begin{aligned}
I(\theta_e,\phi_e,\chi,\gamma) &= F_{00}(\theta_e) + F_{20}(\theta_e)\left[-\frac{1}{2}P_2^0(\cos\chi) + \frac{1}{4}t_1(\gamma)P_2{}^2(\cos\chi)\right] \\
&+F_{21}(\theta_e)\left\{\left[-\frac{1}{2}-\frac{1}{2}t_1(\gamma)\right]P_2{}^1(\cos\chi)\cos(\phi_e) - \frac{3}{2}t_2(\gamma)P_1{}^1(\cos\chi)\sin(\phi_e)\right\} \\
&+F_{22}(\theta_e)\left\{\left[-\frac{1}{2}P_2{}^2(\cos\chi) + t_1(\gamma)\left(2+P_2^0(\cos\chi)\right)\right]\cos(2\phi_e) + 3t_2(\gamma)P_1^0(\cos\chi)\sin(2\phi_e)\right\} \\
&-s_3F_{11}(\theta_e)P_1{}^1(\cos\chi)\sin(\phi_e)
\end{aligned}$$

$$\begin{aligned}
\text{with } t_1(\gamma) &= s_1\cos(2\gamma) - s_2\sin(2\gamma) \\
t_2(\gamma) &= s_1\sin(2\gamma) + s_2\cos(2\gamma)
\end{aligned} \tag{2}$$