Supplementary Data 1

Upper panel:
Observed scattering images at different spectral positions within the Q-branch peak of the $1^1_1$ band indicated in the lower panel. No discrete rings in the backward direction were observed except for (h), for which the UV two-photon energy is resonant with the O(3) and P(5) rotational lines of the origin band. The spike spot in the backward direction is the background
from impurities in the O₂ beam.

Lower panel:
An expanded view of the (2+1) REMPI spectrum observed using a linearly polarized beam at the Q-branch peak of the $1^1$ band. The arrows (a–j) indicate the spectral position at which the scattering image in the upper panel was observed.
State-resolved pair-correlated differential cross sections obtained from the scattering images of CD$_3$ ($\nu = 0$, $N$). (a)–(c) Each rotational state was selected in the S($N$) line. (d)–(f) Rotational state region was selected at different positions within the Q-branch. Red: $v_{OD} = 3$, green: $v_{OD} = 4$, blue: $v_{OD} = 5$, black: $v_{OD} = 6$. 

Supplementary Data 2
State-resolved pair-correlated differential cross sections obtained from the scattering images of CD$_3$ ($v_2 = 2$, $N$). Each rotational state region was selected at different positions within the Q-branch peak. Red: $v_{OD} = 3$, green: $v_{OD} = 4$, blue: $v_{OD} = 5$, black: $v_{OD} = 6$. 