Computational light scattering (PAP315)

Lecture 2a

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$$I \propto E_{\parallel}E_{\parallel}^{*} + E_{\perp}E_{\perp}^{*}$$

$$Q \propto E_{\parallel}E_{\parallel}^{*} - E_{\perp}E_{\perp}^{*}$$

$$U \propto E_{\parallel}E_{\perp}^{*} + E_{\perp}E_{\parallel}^{*}$$

$$V \propto i(E_{\parallel}E_{\perp}^{*} - E_{\perp}E_{\parallel}^{*})$$

I = intensity
Q and *U* = the degree and direction of linear polarization
V = the degree and handedness of the circular polarization.

$$\sqrt{Q^2 + U^2 + V^2} / I = \text{degree of polarization}$$

$$\sqrt{Q^2 + U^2} / I = \text{degree of linear polarization}$$

$$V / I = \text{degree of circular polarization}$$

Nousiainen and Zubko, Lecture Notes, 2011

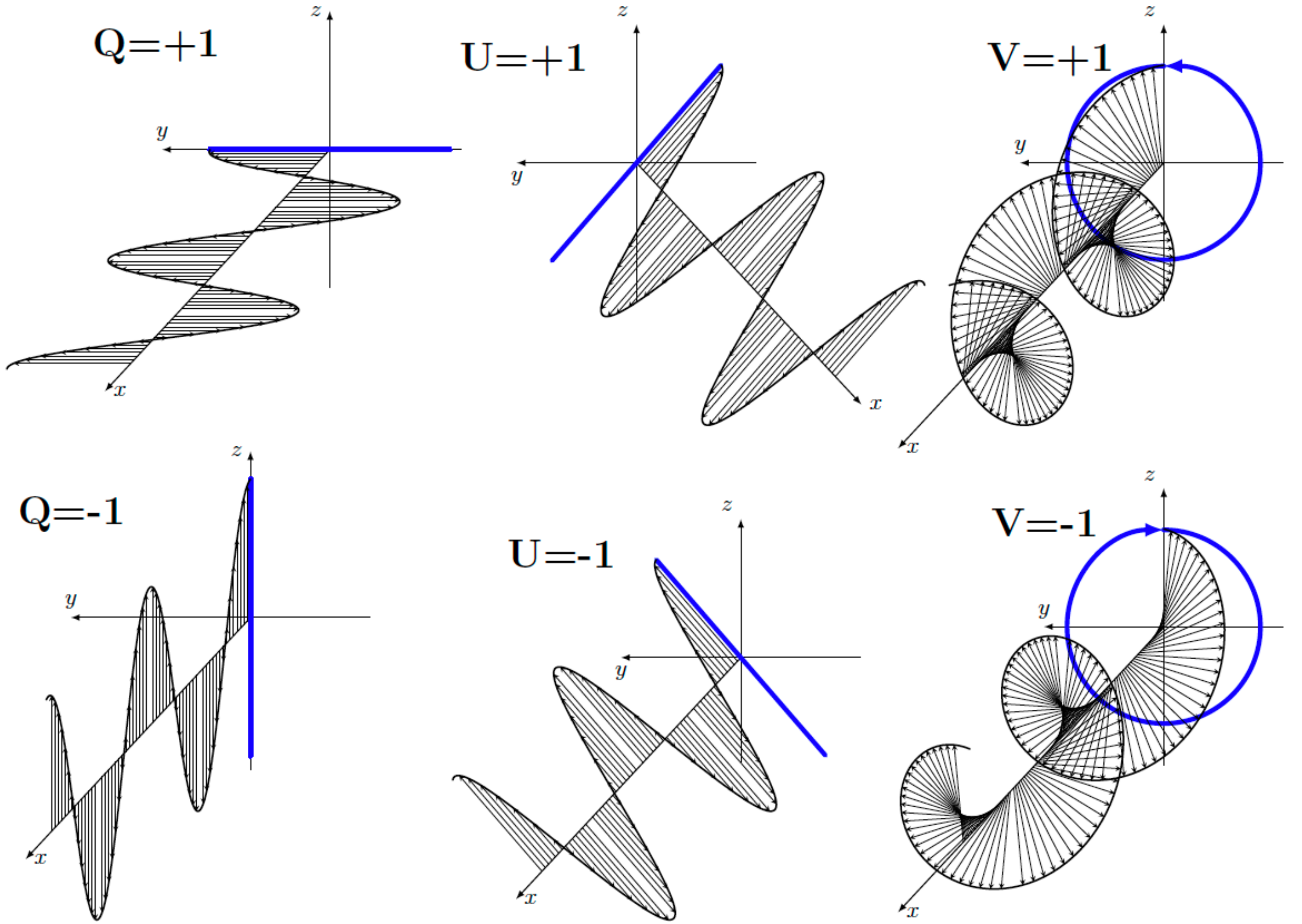

Figure 2.1: Stokes parameters explained visually by drawing the plane of propagation. While Q and U propagate in a plane, the plane of V rotates and thus has a circular pattern. The sign controls the orientation of the plane, whereas intensity I defines the amplitude of the oscillation. For a visual aid, U=-1 propagates in the same direction as U=+1, but the x-axis is shifted to make the pattern more distinctive.

Väisänen, Ph.D. thesis, 2020

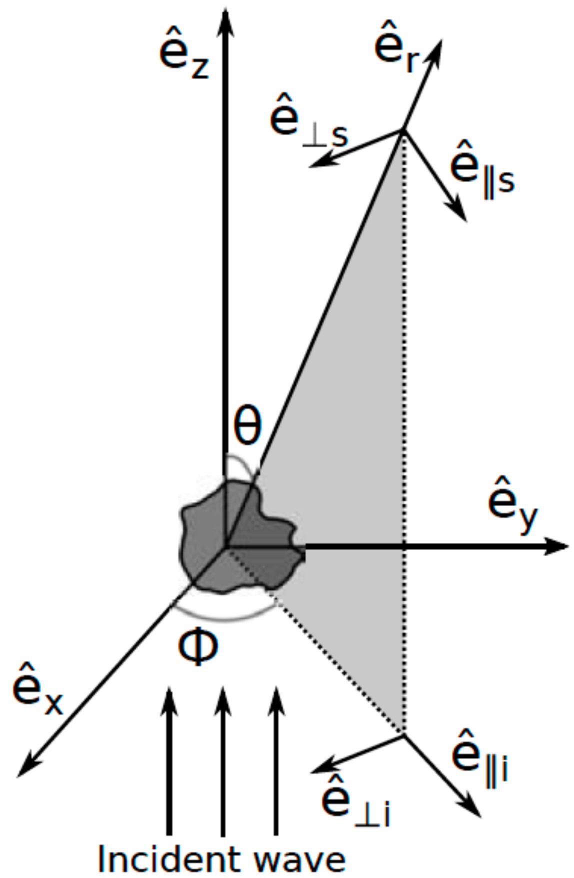

Figure 2.2: Illustration of the incident wave and the scattering plane. (Bohren and Huffman, 1983)

Väisänen, Ph.D. thesis, 2020

With Stokes parameters, we obtain the 4×4 Mueller matrix form for the scattering equation:

$$\begin{pmatrix} I_s \\ Q_s \\ U_s \\ V_s \end{pmatrix} = \frac{C_{sca}}{4\pi d^2} \begin{pmatrix} P_{11} & P_{12} & P_{13} & P_{14} \\ P_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{pmatrix} \begin{pmatrix} I_i \\ Q_i \\ U_i \\ V_i \end{pmatrix}$$

C_{sca} = scattering cross section
d = distance from the scatterer
P = phase matrix

Nousiainen and Zubko, Lecture Notes, 2011