In terms of the usual 3-D spherical-polar coordinate system's ***polar*** and ***azimuthal*** angles θ and φ, respectively it is straightforward to show that:

$$\cos\Theta_x = \sin\theta\cos\varphi\,,$$
$$\cos\Theta_y = \sin\theta\sin\varphi \quad \text{and}$$
$$\cos\Theta_z = \cos\theta\,,\ \textit{i.e.}\ \text{ that }\ \Theta_z = \theta\,.$$

Likewise, the wavevector $\vec{k} = k_x\hat{x} + k_y\hat{y} + k_z\hat{z}$ has its own direction cosines:

$$\cos\Theta_{k_x} \equiv \hat{k}\bullet\hat{x} = k_x\Big/\sqrt{k_x^2+k_y^2+k_z^2} = k_x\Big/\left|\vec{k}\right| = k_x/k\,,$$
$$\cos\Theta_{k_y} \equiv \hat{k}\bullet\hat{y} = k_y\Big/\sqrt{k_x^2+k_y^2+k_z^2} = k_y\Big/\left|\vec{k}\right| = k_y/k \quad \text{and}$$
$$\cos\Theta_{k_z} \equiv \hat{k}\bullet\hat{z} = k_z\Big/\sqrt{k_x^2+k_y^2+k_z^2} = k_z\Big/\left|\vec{k}\right| = k_z/k\,.$$

Note again that: $\left|\hat{k}\bullet\hat{k}\right|^2 = \cos^2\Theta_{k_x} + \cos^2\Theta_{k_y} + \cos^2\Theta_{k_z} = 1$.

If we were to imagine 1-D complex monochromatic traveling plane waves propagating in the $\hat{k}_x = \pm\hat{x}$, $\hat{k}_y = \pm\hat{y}$ and $\hat{k}_z = \pm\hat{z}$ -directions we would describe each of these mathematically as:

Prop. in $\hat{k}_x = \pm\hat{x}$-direction: $\tilde{\psi}_x(\vec{r},t) = A\left\{\cos(\omega t \mp k_x x) + i\sin(\omega t \mp k_x x)\right\} = Ae^{i(\omega t \mp k_x x)}$

Prop. in $\hat{k}_y = \pm\hat{y}$-direction: $\tilde{\psi}_y(\vec{r},t) = A\left\{\cos(\omega t \mp k_y y) + i\sin(\omega t \mp k_y y)\right\} = Ae^{i(\omega t \mp k_y y)}$

Prop. in $\hat{k}_z = \pm\hat{z}$-direction: $\tilde{\psi}_z(\vec{r},t) = A\left\{\cos(\omega t \mp k_z z) + i\sin(\omega t \mp k_z z)\right\} = Ae^{i(\omega t \mp k_z z)}$

From these relations, noting that $\vec{k}\bullet\vec{r} = (k_x\hat{x} + k_y\hat{y} + k_z\hat{z})\bullet(x\hat{x} + y\hat{y} + z\hat{z}) = k_x x + k_y y + k_z z$, we can generalize to the case for a complex monochromatic traveling plane wave propagating in an *arbitrary* direction $\hat{k} = (k_x\hat{x} + k_y\hat{y} + k_z\hat{z})\Big/\left|\vec{k}\right| = (k_x\hat{x} + k_y\hat{y} + k_z\hat{z})\Big/k$ in 3-D space:

Prop. in $\hat{k}$-direction: $\tilde{\psi}(\vec{r},t) = A\left\{\cos(\omega t \mp \vec{k}\bullet\vec{r}) + i\sin(\omega t \mp \vec{k}\bullet\vec{r})\right\} = Ae^{i(\omega t \mp \vec{k}\bullet\vec{r})}$

The above expression for a complex monochromatic traveling plane wave propagating in an arbitrary direction $\hat{k}$ in 3-D space is an appropriate description for a complex ***scalar*** field – *e.g.* complex pressure $\tilde{p}(\vec{r},t)$ – because ***scalar*** fields $\tilde{\psi}(\vec{r},t)$ at each/every space-time point $(\vec{r},t)$ have ***no*** explicit direction associated with them, other than their propagation direction $\hat{k}$.

We can also easily generalize the above complex scalar traveling wave description $\tilde{\psi}(\vec{r},t)$ to describe 3-D complex ***vector*** monochromatic traveling plane waves propagating in an arbitrary direction $\hat{k}$ in 3-D space – *e.g.* complex particle displacement $\tilde{\vec{\xi}}(\vec{r},t)$, particle velocity $\tilde{\vec{u}}(\vec{r},t)$ and/or particle acceleration $\tilde{\vec{a}}(\vec{r},t)$. We can mathematically describe "generic" 3-D complex vector fields *e.g.* in Cartesian / rectangular coordinates in the following form:

$$\tilde{\vec{\psi}}(\vec{r},t) = \tilde{\psi}_x(\vec{r},t)\,\hat{x} + \tilde{\psi}_y(\vec{r},t)\,\hat{y} + \tilde{\psi}_z(\vec{r},t)\,\hat{z}\,.$$