Note also that ***both*** the ***time-domain*** complex pressure $\tilde{p}(\vec{r},t)$ and the ***time-domain*** complex 3-D particle velocity $\tilde{\vec{u}}(\vec{r},t)$ associated *e.g.* with a single frequency (*aka* harmonic) sound field will in general have time dependence of the form $e^{i\omega t}$. Thus, since the 3-D specific acoustic immittances are defined as ***ratios*** of these two quantities, the $e^{i\omega t}$ factor in the both the numerator and the denominator of the ratios $\tilde{\vec{y}}_a(\vec{r},t)=\tilde{\vec{u}}(\vec{r},t)/\tilde{p}(\vec{r},t)$ and $\tilde{\vec{z}}_a(\vec{r},t)=\tilde{p}(\vec{r},t)/\tilde{\vec{u}}(\vec{r},t)$ ***cancels*** for harmonic/single-frequency complex sound fields, thus we see that the complex 3-D vector specific acoustic immittances are in fact ***time-independent*** quantities… In fact, they are manifestly ***frequency domain*** quantities!

$$\text{Time Domain: } \tilde{\vec{y}}_a(\vec{r},t)\equiv\frac{\tilde{\vec{u}}(\vec{r},t)}{\tilde{p}(\vec{r},t)}=\frac{\tilde{\vec{u}}(\vec{r},\omega)\cancel{e^{i\omega t}}}{\tilde{p}(\vec{r},\omega)\cancel{e^{i\omega t}}}=\frac{\tilde{\vec{u}}(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}\equiv\tilde{\vec{y}}_a(\vec{r},\omega)\text{ Frequency Domain}$$

$$\text{Time Domain: } \tilde{\vec{z}}_a(\vec{r},t)\equiv\frac{\tilde{p}(\vec{r},t)}{\tilde{\vec{u}}(\vec{r},t)}=\frac{\tilde{p}(\vec{r},\omega)\cancel{e^{i\omega t}}}{\tilde{\vec{u}}(\vec{r},\omega)\cancel{e^{i\omega t}}}=\frac{\tilde{p}(\vec{r},\omega)}{\tilde{\vec{u}}(\vec{r},\omega)}\equiv\tilde{\vec{z}}_a(\vec{r},\omega)\text{ Frequency Domain}$$

Complex 3-D *Specific* Acoustic Immittances (for Harmonic Sound Fields):

Complex *Specific* Acoustic Impedance:

$$\tilde{\vec{z}}_a(\vec{r},\omega)\equiv\frac{\tilde{p}(\vec{r},\omega)}{\tilde{\vec{u}}(\vec{r},\omega)}=\frac{1}{\tilde{\vec{y}}_a(\vec{r},\omega)}\quad(\Omega_a=Rayl)$$

Time-independent quantity!
⇒ Frequency-domain quantity!

Complex *Specific* Acoustic Admittance:

$$\tilde{\vec{y}}_a(\vec{r},\omega)\equiv\frac{\tilde{\vec{u}}(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}=\frac{1}{\tilde{\vec{z}}_a(\vec{r},\omega)}\quad(\Omega_a^{-1}=Rayl^{-1})$$

Time-independent quantity!
⇒ Frequency-domain quantity!

The time-independent complex ***specific*** acoustic immittances are 3-D ***vector frequency-domain*** quantities. Their 3-D *x-y-z* Cartesian ***frequency-domain*** components can be explicitly written out as:

$$\begin{aligned}\tilde{\vec{y}}_a(\vec{r},\omega)&=\tilde{y}_{a_x}(\vec{r},\omega)\hat{x}+\tilde{y}_{a_y}(\vec{r},\omega)\hat{y}+\tilde{y}_{a_z}(\vec{r},\omega)\hat{z}\\&=\frac{\tilde{u}_x(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}\hat{x}+\frac{\tilde{u}_y(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}\hat{y}+\frac{\tilde{u}_z(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}\hat{z}=\frac{\tilde{\vec{u}}(\vec{r},\omega)}{\tilde{p}(\vec{r},\omega)}=\frac{1}{\tilde{\vec{z}}_a(\vec{r},\omega)}\end{aligned}$$

$$\begin{aligned}\tilde{\vec{z}}_a(\vec{r},\omega)&=\tilde{z}_{a_x}(\vec{r},\omega)\hat{x}+\tilde{z}_{a_y}(\vec{r},\omega)\hat{y}+\tilde{z}_{a_z}(\vec{r},\omega)\hat{z}=\frac{\tilde{p}(\vec{r},\omega)}{\tilde{\vec{u}}(\vec{r},\omega)}=\frac{1}{\tilde{\vec{y}}_a(\vec{r},\omega)}\\&=\frac{\tilde{p}(\vec{r},\omega)\tilde{u}_x^*(\vec{r},\omega)}{\left|\tilde{\vec{u}}(\vec{r},\omega)\right|^2}\hat{x}+\frac{\tilde{p}(\vec{r},\omega)\tilde{u}_y^*(\vec{r},\omega)}{\left|\tilde{\vec{u}}(\vec{r},\omega)\right|^2}\hat{y}+\frac{\tilde{p}(\vec{r},\omega)\tilde{u}_z^*(\vec{r},\omega)}{\left|\tilde{\vec{u}}(\vec{r},\omega)\right|^2}\hat{z}=\frac{\tilde{p}(\vec{r},\omega)\tilde{\vec{u}}^*(\vec{r},\omega)}{\left|\tilde{\vec{u}}(\vec{r},\omega)\right|^2}\end{aligned}$$