



$$\begin{aligned}
 \mathbf{C}_{DA} &= \mathbf{C}_{DC} \mathbf{C}_{CB} \mathbf{C}_{BA} \Rightarrow D\mathbf{r} = \mathbf{C}_{DA} A\mathbf{r} \\
 &= \begin{pmatrix} \cos \alpha & \sin \alpha & 0 \\ -\sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos \beta & 0 & -\sin \beta \\ 0 & 1 & 0 \\ \sin \beta & 0 & \cos \beta \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \alpha & \sin \alpha \\ 0 & -\sin \alpha & \cos \alpha \end{pmatrix} \\
 &= \begin{pmatrix} \cos \beta \cos \gamma & \cos \alpha \sin \gamma + \cos \gamma \sin \alpha \sin \beta & \sin \alpha \sin \gamma - \cos \alpha \cos \gamma \sin \beta \\ -\cos \beta \sin \gamma & \cos \alpha \cos \gamma - \sin \alpha \sin \beta \sin \gamma & \cos \gamma \sin \alpha + \cos \alpha \sin \beta \sin \gamma \\ \sin \beta & -\cos \beta \sin \alpha & \cos \alpha \cos \beta \end{pmatrix} \\
 \mathbf{C}_{AD} &= \mathbf{C}_{DA}^T \\
 &= \begin{pmatrix} \cos \beta \cos \gamma & \cos \alpha \sin \gamma + \cos \gamma \sin \alpha \sin \beta & \sin \alpha \sin \gamma - \cos \alpha \cos \gamma \sin \beta \\ -\cos \beta \sin \gamma & \cos \alpha \cos \gamma - \sin \alpha \sin \beta \sin \gamma & \cos \gamma \sin \alpha + \cos \alpha \sin \beta \sin \gamma \\ \sin \beta & -\cos \beta \sin \alpha & \cos \alpha \cos \beta \end{pmatrix}
 \end{aligned}$$