The Auditory System and Human Sound-Localization Behavior
Short Answers Exercises Chapter 11: Reference frames.

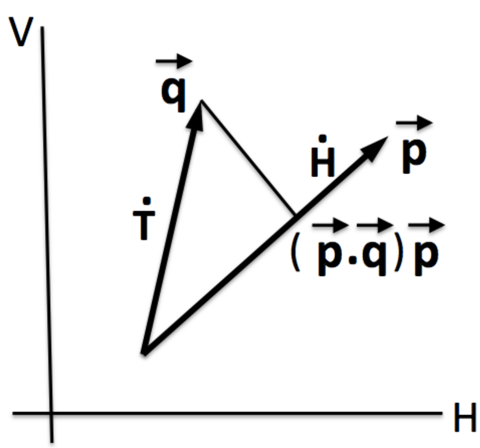
Exercise 11.1:
The equation is given as a weighted combination of target motion re. world and head motion re. world, both potentially leading to a change in perceived ILD:

$$\frac{\Delta ILD(t)}{\Delta t} = p \cdot \dot{H}_w(\alpha) + q \cdot \dot{T}_w(\alpha)$$

with p and q coefficients. Both movement components take place in the horizontal plane (azimuth), but in general they could be in any direction through space. However, the ILD change only depends on the target's speed relative to the head in the horizontal plane! So, given the two components above, it follows that

$$p = -q$$

Indeed, if the target moves at the same speed through the world as the head, the ILDs won't change.
For the more general case, the coefficients for head-in-world and target-in-world motions are vectorial quantities: $\vec{p} = (p_H, p_V)$ and $\vec{q} = (q_H, q_V)$, with H and V world-centred coordinates. Note that the ILDs will vary with the component along the interaural axis....



Exercise 11.2:
The appearance of a gain field (Eqn. 11.7) may follow from a first-order Taylor approximation on the Gaussian activity profile in the SC motor map in (u, v) coordinates, in which an eye-position signal modulates the population width ($\alpha \equiv 1(2\sigma^2)$):

$$F(u, v, \Delta E_0) = F_0 \cdot \exp(-\alpha \Delta E_0 \cdot (u^2 + v^2))$$

Let's take only an eye-position sensitivity along the u-direction (1D problem):

$$F(u, \Delta E_0) \approx F(u, 0) \cdot (1 - 2\Delta E_0 \cdot \alpha \cdot u)$$

When expressed as function of stimulus eccentricity, the complex-log mapping function

$$u = B_u \cdot \ln(1 + R/A)$$

leads to

$$F(R, \Delta E_0) \approx F(R, 0) \cdot (1 - 2\alpha A B_u \cdot \Delta E_0) \equiv (1 + \varepsilon \cdot \Delta E_0) \cdot F(R, 0)$$

Exercise 11.3:

For simplicity, we assume that the target is presented at $t = 0$ at exactly straight ahead, so that the chair's rotation will either lead to a positive (rightward) or negative (leftward) change in the ITD/ILD at the time of stimulus offset when the target is world-fixed. Clearly, when the target is chair-fixed the ITD/ILD remains zero, regardless the chair's rotation direction.
At v deg/s the chair moves in ΔT sec

$$\alpha_{\text{ROT}}(v, \Delta T) = v \cdot \Delta T \cdot 10^{-3} \text{ deg}$$

Compute the resulting ILDs and ITDs by using Eqns. 7.22 and 7.3, respectively.
Given the resolution of the auditory system (about 0.7 deg, see Chapter 7), the only stimulus that may provide evidence for a world-fixed vs. a head-fixed sound is the 10 ms sound burst. All other stimuli will generate changes in ILD and ITD that fall below the system's best resolution.