

56. The Doppler shift formula, Eq. 18-47, is valid only when both  $u_S$  and  $u_D$  are measured with respect to a stationary medium (i.e., no wind). To modify this formula in the presence of a wind, we switch to a new reference frame in which there is no wind.

- (a) When the wind is blowing from the source to the observer with a speed  $w$ , we have  $u'_S = u'_D = w$  in the new reference frame that moves together with the wind. Since the observer is now approaching the source while the source is backing off from the observer, we have, in the new reference frame,

$$f' = f \left( \frac{v + u'_D}{v + u'_S} \right) = f \left( \frac{v + w}{v + w} \right) = 2000 \text{ Hz} .$$

In other words, there is no Doppler shift.

- (b) In this case, all we need to do is to reverse the signs in front of both  $u'_D$  and  $u'_S$ . The result is that there is still no Doppler shift:

$$f' = f \left( \frac{v - u'_D}{v - u'_S} \right) = f \left( \frac{v - w}{v - w} \right) = 2000 \text{ Hz} .$$

In general, there will always be no Doppler shift as long as there is no relative motion between the observer and the source, regardless of whether a wind is present or not.