Doppler Shift for E-M Waves

What's Different from Sound or Water Waves ?

Sound /Water Waves :
You can calculate (no relativity needed)
BUT
Result is somewhat complicated: is source or observer moving wrt medium?

Electromagnetic Waves :
You need relativity (time dilation) to calculate
BUT
Result is simple: only depends on relative motion of source & observer

$$f' = f\left(\frac{1+\beta}{1-\beta}\right)^{\frac{1}{2}}$$

$$\beta = v/c$$

$\beta > 0$ if source & observer are approaching

$\beta < 0$ if source & observer are separating