[lex92] Internal clock of pions

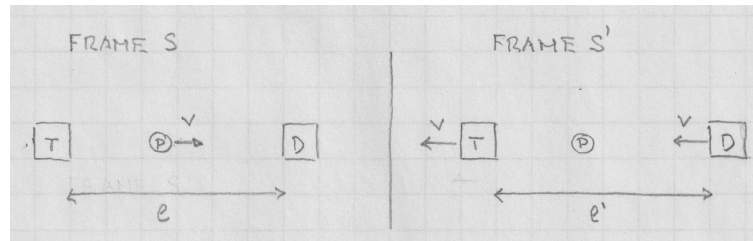Pions in their rest frame S' decay according to the empirical law,

$$\frac{N(t')}{N_0} = 2^{-t'/T},$$

where $T \simeq 1.8 \times 10^{-8}$s is the half-life for these particles. Researchers at Fermilab create high-energy pulses of pions and observe that two thirds of these particles reach a detector at a distance $\ell = 35$m (in the lab frame S) from the point where they were created (target).

(a) Find the velocity v of the pions in units of c.

(b) Find the distance ℓ' between target and detector in the rest frame of the particles.

Hint: Start out by identifying proper times and proper lengths. Then relate them to dilated times and contracted lengths.

Solution: