

### Feynman and Hibbs problem 3-1

Let the classical momentum at  $x = a$  be somewhere between zero and  $p$ . Then from  $p = mv$  we have the following maximum distance  $d$ .

$$d = \frac{p}{m}(t_b - t_a)$$

Hence the normalization constant  $C$  is

$$\begin{aligned} C &= \int_a^{a+d} \frac{m}{2\pi\hbar(t_b - t_a)} dx \\ &= \left. \frac{mx}{2\pi\hbar(t_b - t_a)} \right|_a^{a+d} \\ &= \frac{m(a+d)}{2\pi\hbar(t_b - t_a)} - \frac{ma}{2\pi\hbar(t_b - t_a)} \\ &= \frac{md}{2\pi\hbar(t_b - t_a)} \\ &= \frac{p}{2\pi\hbar} \end{aligned}$$

Hence diverging normalization corresponds to unrestricted momentum  $p$ .

Given

$$x + dx = \frac{p + dp}{m}(t_b - t_a)$$

we have

$$dx = \frac{dp}{m}(t_b - t_a)$$

It follows that

$$\frac{m}{2\pi\hbar(t_b - t_a)} dx = \frac{dp}{2\pi\hbar}$$