Семинар
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30.XII.2019

Кое-что о фазе амплитуды рассеяния

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Пример из квантовой механики

$$\langle x_i \rangle = \int d^3x x_i |\Psi(\boldsymbol{x})|^2 = \int \frac{d^3p}{(2\pi)^3} \frac{d\Phi(\boldsymbol{p})}{dp_i} \left|\tilde{\Psi}(\boldsymbol{p})\right|^2 = \left\langle \frac{d\Phi}{dp_i} \right\rangle$$

$$\tilde{\Psi}(\boldsymbol{p}) = \left|\tilde{\Psi}(\boldsymbol{p})\right| e^{i\Phi(\boldsymbol{p})} = \int d^3x e^{i\boldsymbol{p}x} \Psi(\boldsymbol{x})$$

Вывод: фаза определена с точностью до постоянной

Амплитуда в 1-полюсной Редже модели

$$T(s,t) = \beta(t)(e^{-i\frac{\pi}{2}}s)^{\alpha(t)} = (\beta(t)s^{\alpha(t)})e^{-i\frac{\pi\alpha(t)}{2}}$$

$$ArgT(s,t) = \Phi(s,t) = -\frac{\pi\alpha(t)}{2}$$

$$\langle (\Delta x_\perp)^2 \rangle \approx 4\alpha'(0)\ln s + \left\langle \left(\frac{\partial\Phi}{\partial q_\perp}\right)^2 \right\rangle = 4\alpha'(0)\ln s + \frac{\pi^2}{4}(\alpha'(0))^2$$

$$\langle \Delta x_{||} \rangle = \left\langle \frac{\partial\Phi(s,t)}{\partial q_{||}} \right\rangle = -2p \left\langle \frac{\partial\Phi(s,t)}{\partial t} \right\rangle \approx \pi\sqrt{s}\alpha'(0)$$

Мотивация

Формула Бете (1958) для учёта влияния Кулоновских обменов
в рассеянии заряженных частиц

$$T_{C+N} = T_C{}^{Born} + e^{-i\alpha\varphi} T_N$$

$$T_C{}^{Born} = \frac{8\pi s}{t}, \quad T_N = |T_N(s,t)| e^{i\Phi_N(s,t)}$$

$$\varphi(s,t) = \int_{-\infty}^{0} \frac{dt'}{|t-t'|} \left[\frac{T_N(s,t')}{T_N(s,t)} - \theta(t'-t)\right]$$

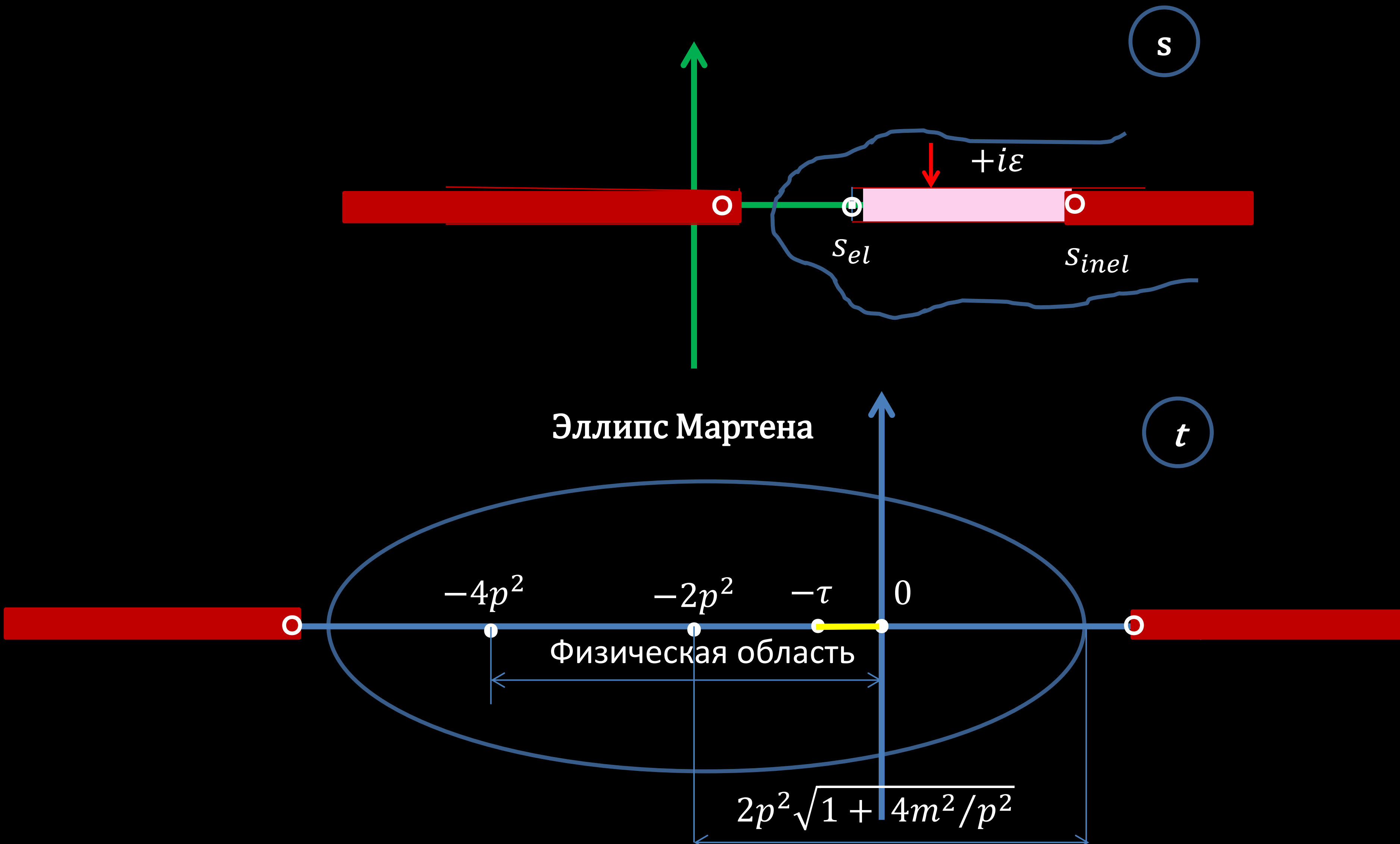
$$\varphi(s,t) = \int_{-\infty}^{0} \frac{dt'}{|t-t'|} \left\{\frac{|T_N(s,t')|}{|T_N(s,t)|} e^{i[\Phi_N(s,t')-\Phi_N(s,t)]} - \theta(t'-t)\right\}$$

$$\frac{\partial \Phi_N(s,t)}{\partial t} \equiv 0$$

$$T_N(s,t) = 4s \frac{i+\rho(s)}{\sqrt{1+\rho^2}} \sqrt{\frac{d\sigma}{dt}|_{t=0}}\, e^{Bt/2}$$

$$\Phi_N(s,t) = arctg \frac{1}{\rho(s)}$$

$$T_N(s;t) = F(s + i\varepsilon, t) = R(s;t) + iI(s;t)$$



$$\frac{R_N(s,t)}{I_N(s,t)} \div \rho(s,t) = ctg\Phi_N(s,t)$$

Theorem I

Let $\rho(s;t)$ is independent on t at $t \in (-\tau, 0]$ and at $s \in [s_1, s_2] \subset [4m^2, +\infty)$. Then $\rho(s;t)$ is independent on t inside the Martin ellipse and, in particular, in the whole physical region $-4p^2 \leq t \leq 0$ with $s \in \forall[s_1, s_2] \subset [4m^2, +\infty)$.

Theorem II

If the phase $\Phi_N(s;t)$ of the physical scattering amplitude

$$T_N(s;t) = \mid T_N(s;t) \mid \exp(i\Phi_N(s;t))$$

is independent on t at $t \in (-\tau, 0]$, where a positive number τ is arbitrarily small and the energy region contains the values $s \in [s_1, s_2] \subset [s_{inel} - \Delta s, s_{inel})$,where s_{inel} denotes the lowest inelastic threshold and $\Delta s \ll s_{inel}$, then $T_N(s,t) \equiv 0$ in all physical region of t and s.

Обсуждение

$$ReT(s,t) = \rho(s) ImT(s,t)$$

$$s \gg -t$$

$$\rho(s) \approx \frac{\mathcal{P}}{\pi} \int_{4m^2}^{\infty} \frac{2s'ds'}{s'^2 - s^2} \frac{Im\,T(s',t)}{Im\,T(s,t)}$$

$$\downarrow$$

$$T(s;t) = H(s) \cdot G(t)$$

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