New source model

Maxi Horst

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Basic idea

- Create a source model in EPOS which will reproduce the size and m_T scaling of the measurement
- Basic idea: force Primordials to reproduce the core source
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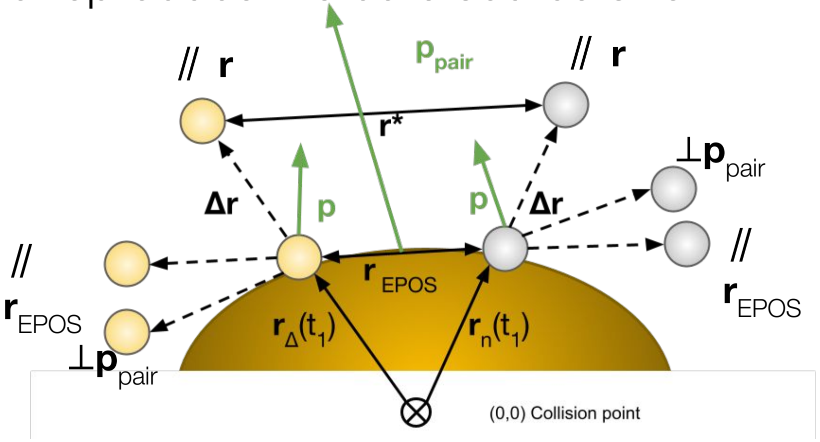

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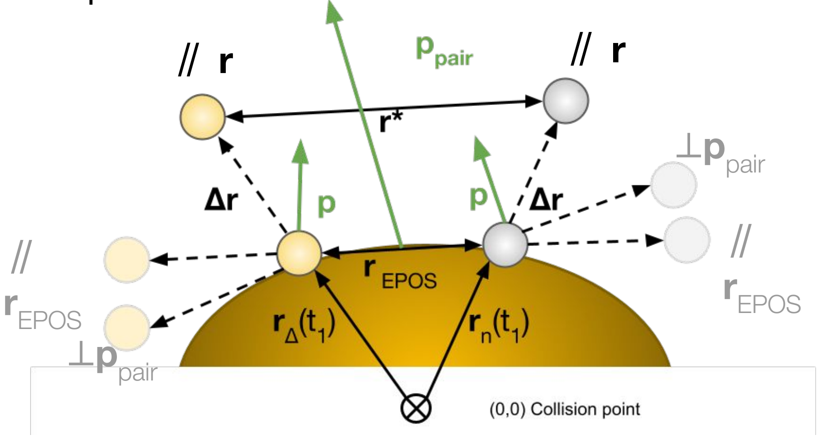
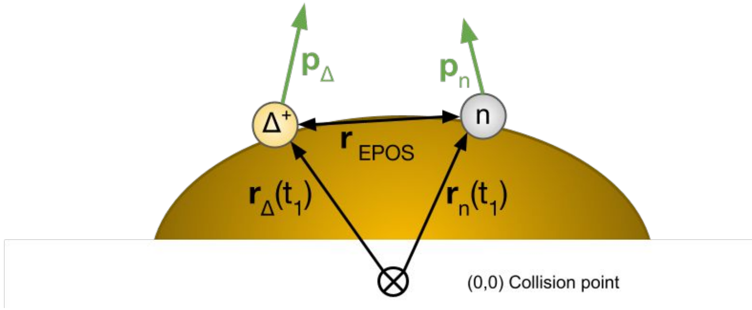


The new source model

Step-by-step

1. Propagate primordials (resonances **and** nucleons) to equal times



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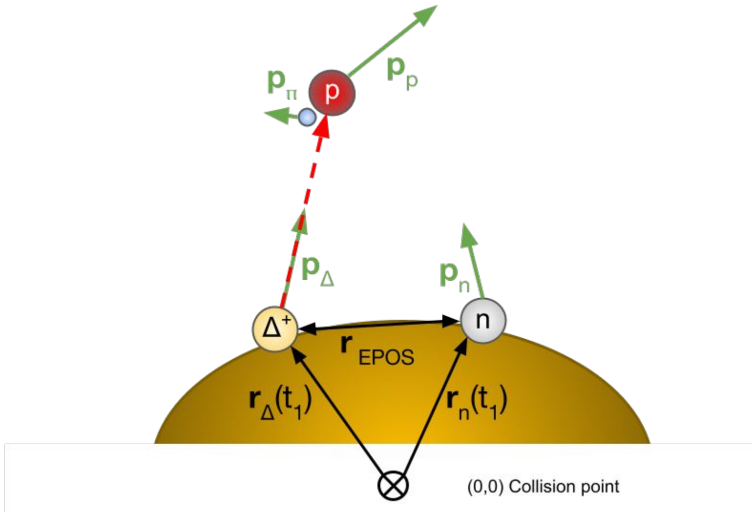

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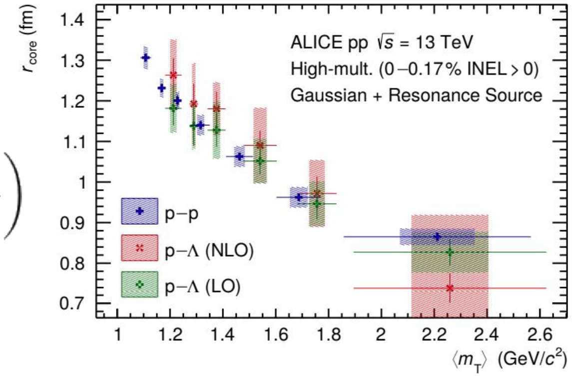
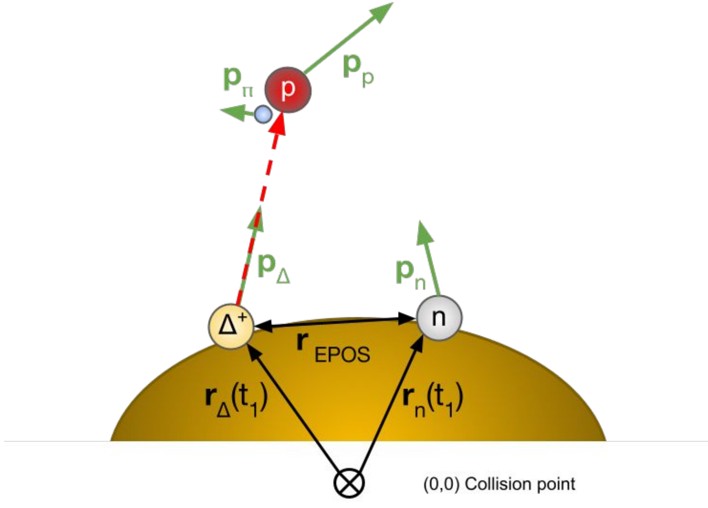
$$S(r^*) = \frac{4\pi r^{*2}}{(4\pi r_{core}^2)^{3/2}} * \exp\left(-\frac{r^{*2}}{4r_{core}^2}\right)$$





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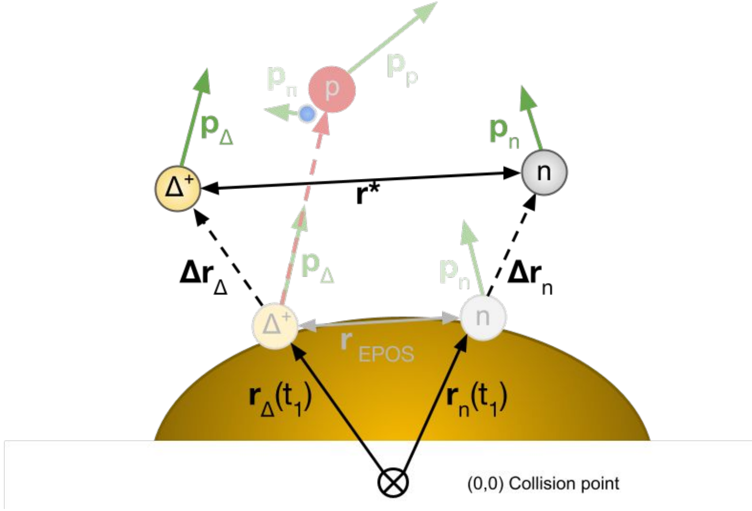
4. Move primordials along their position vector until we reach a distance of r*



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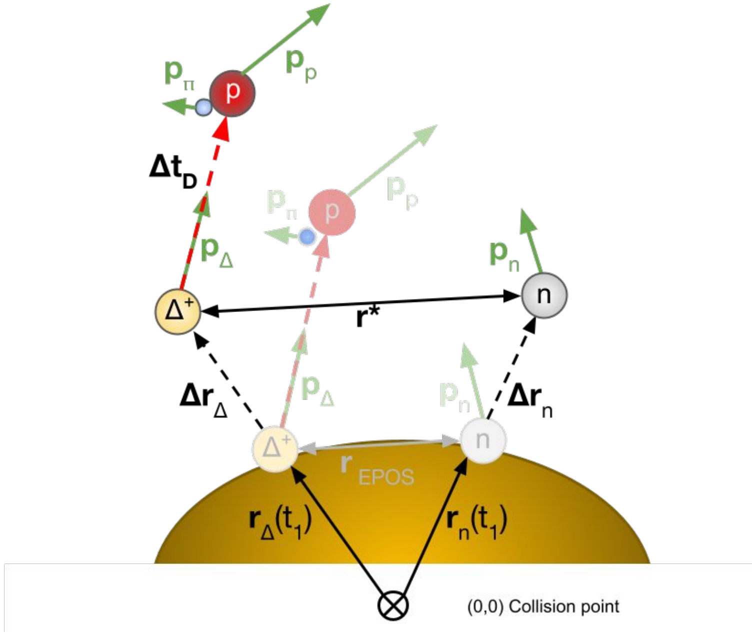

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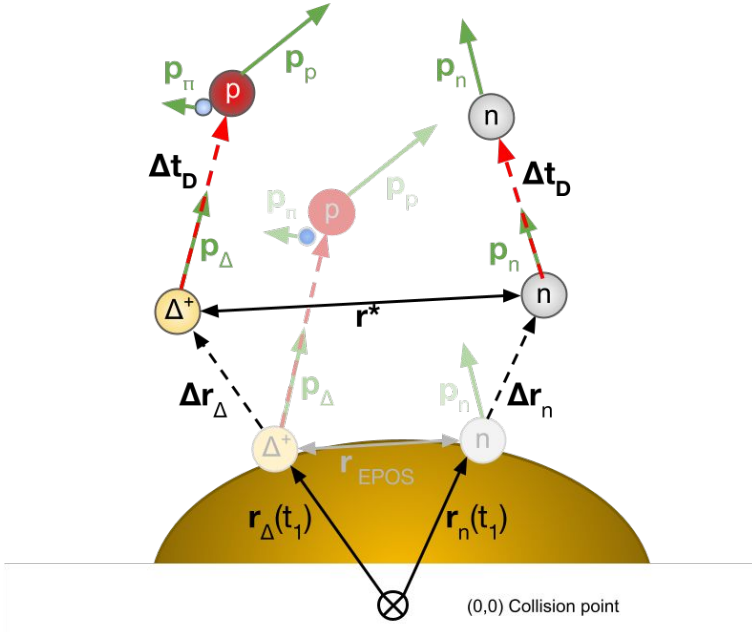

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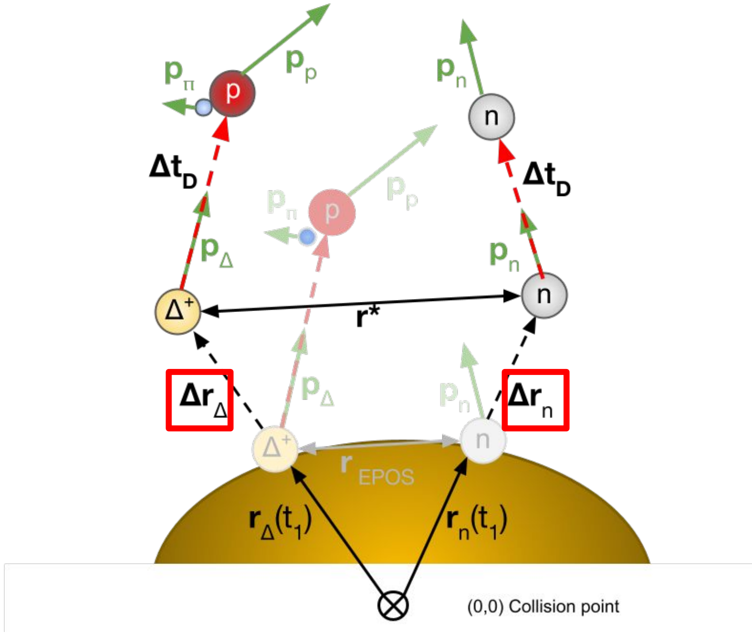

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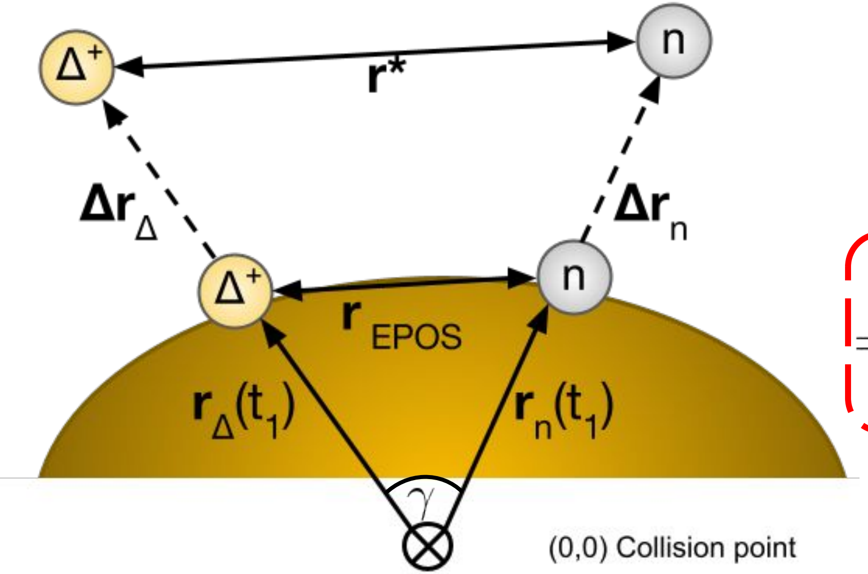
Calculating Δr



$$R = r_n / r_\Delta,\quad \Delta r^* = r^* - r_E \qquad \Delta r_n = R \cdot \Delta r^*_\Delta$$

using: $c^2 = a^2 + b^2 + 2ab\cos\gamma$

$$\Leftrightarrow \Delta r^{*2} = \Delta r_n^{\;2} + \Delta r_\Delta^{\;2} + 2\Delta r_n \Delta r_\Delta \cos\gamma$$

$$\boxed{\Rightarrow \Delta r_\Delta = \frac{\Delta r^*}{\sqrt{R^2 + 1 - 2R\cos\gamma}} = \Delta r_n / R}$$

Shao et al. Coalescence paper

Production of light antinuclei in pp collisions by dynamical coalescence and their fluxes in cosmic rays near earth

(https://arxiv.org/pdf/2205.13626.pdf)

Shao et al. Coalescence paper

Coalescence model used

- They don’t describe their Coalescence model in detail
- Ref [38]: (same model, but for $^3_\Lambda$H and ^{3}He https://arxiv.org/pdf/0908.3357.pdf)

tonic and hadronic effect. The overlap Wigner phase-space density of the three-hadron cluster, $^3_\Lambda$H(p,n,Λ) and ^{3}He(p,p,n), is then calculated as discussed above, and a Monte-Carlo sampling is employed to determine if the cluster is to form a nucleus or not. A nucleus emerges if the current sample value ρ is less than $\rho^W_{^3_\Lambda\mathrm{H}(^3\mathrm{He})}$. Figure 1

$$\rho^W_{^3_\Lambda\mathrm{H}(^3\mathrm{He})} = 8^2 \exp\left(-\frac{\rho^2+\lambda^2}{b^2}\right)\exp\left(-(\mathbf{k}_\rho^2+\mathbf{k}_\lambda^2)b^2\right)$$

- A little unclear, but it looks like they use the Wigner function as a probability and use a statistical rejection method

BACKUP

Shao et al. Coalescence paper

Coalescence model used

- They use a “dynamical Coalescence model” which has been in use in the chinese community for a while (oldest reference ~2010) https://arxiv.org/pdf/0908.3357.pdf
- The multiplicity of a cluster of M nucleons (M-Cluster) can be expressed as

$$N_M = G \int d\mathbf{r}_{i_1} d\mathbf{q}_{i_1} \cdots d\mathbf{r}_{i_{M-1}} d\mathbf{q}_{i_{M-1}} \times \langle \sum_{i_1>i_2>\cdots>i_M} \underbrace{\rho_i^W(\mathbf{r}_{i_1}, \mathbf{q}_{i_1} \cdots \mathbf{r}_{i_{M-1}}, \mathbf{q}_{i_{M-1}})}_{\text{Single nucleon phase-space density}} \rangle$$

- A M-Cluster forms a nucleus when the phase-space density of an M-cluster is smaller than the Wigner function of the d/^{3}He/^{3}H/…

$$\rho_{\mathrm{d}}^W(\mathbf{r}, \mathbf{k}) = \int \psi(\mathbf{r} + \frac{\mathbf{R}}{2}) \psi^*(\mathbf{r} + \frac{\mathbf{R}}{2}) \times \exp(-i\mathbf{k} \cdot \mathbf{R}) d^3\mathbf{R} = 8 \exp\left(-\frac{\rho^2}{\sigma_{\mathrm{d}}^2} - \sigma_{\mathrm{d}}^2 \mathbf{k}^2\right)$$

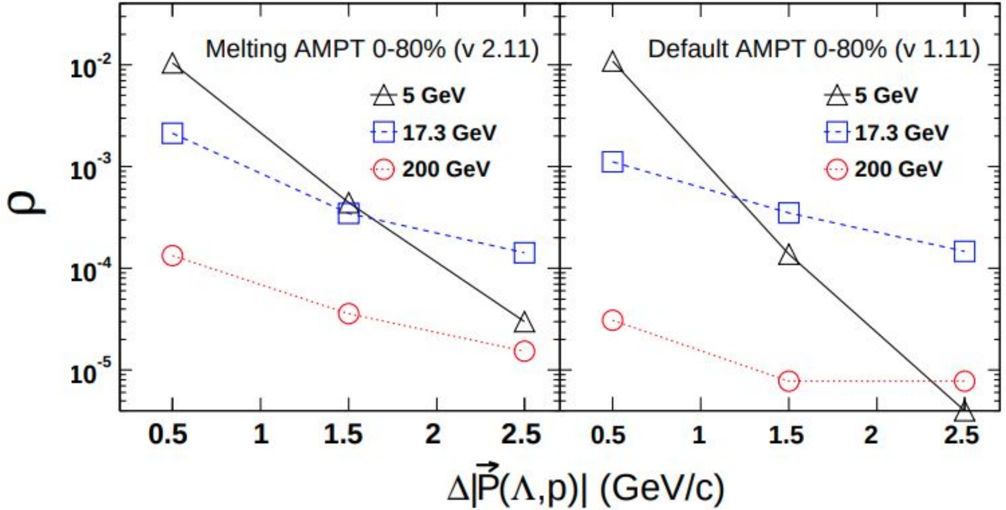


Figure 1: (color online) The Wigner phase-space density ρ for ${}^{3}_{\Lambda}H$ from melting AMPT (left panel) and default AMPT (right panel) as a function of (Λ, p) pair momentum. Densities are shown for $\sqrt{s_{NN}}$ = 5 GeV, 17.3 GeV and 200 GeV. The distributions have been normalized by the number of events at each collision energy.

EPOS productions

Timeline

- Currently there are ~50M events done by the Virgo (GSI) cluster
- Speed is ~10M/day
- We will reach 300M by the end of the month
- LRZ will contribute very few events for technical reason running many jobs does not scale well
- Locally also some events are running at about 2M events/day
- This will contribute ~50M events by the end of the month
- With our existing 100M events we will have 450-500M events by the end of the month

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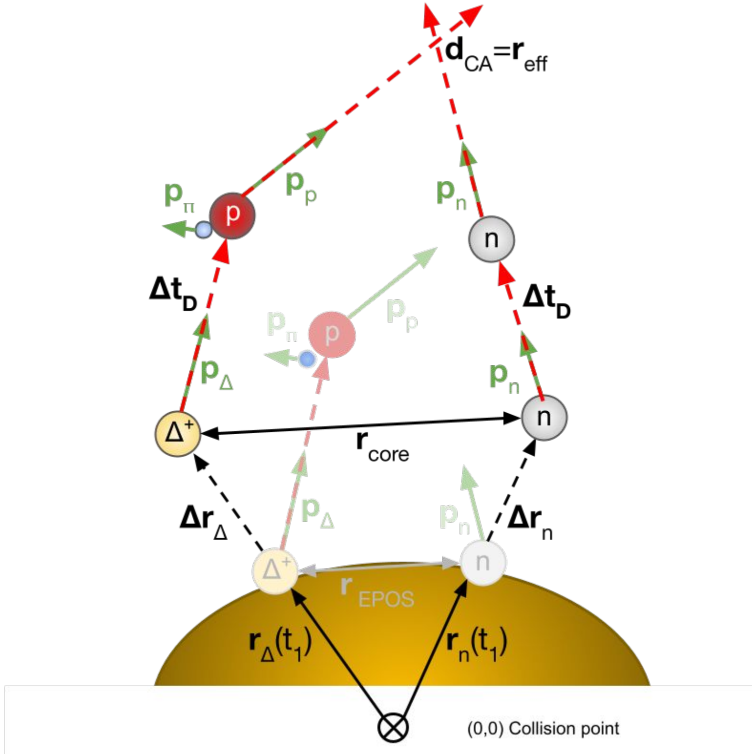
4. Move primordials along their position vector until we reach a distance of r_{core}
5. Add the decay vector to moved resonance
6. Propagate to equal times
7. Calculate d_{CA} to get r_{eff}



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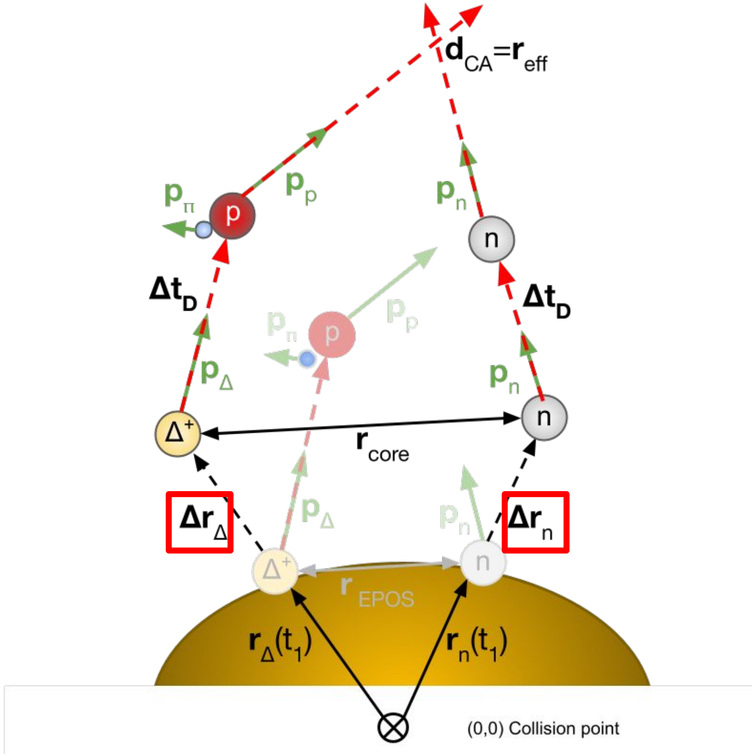

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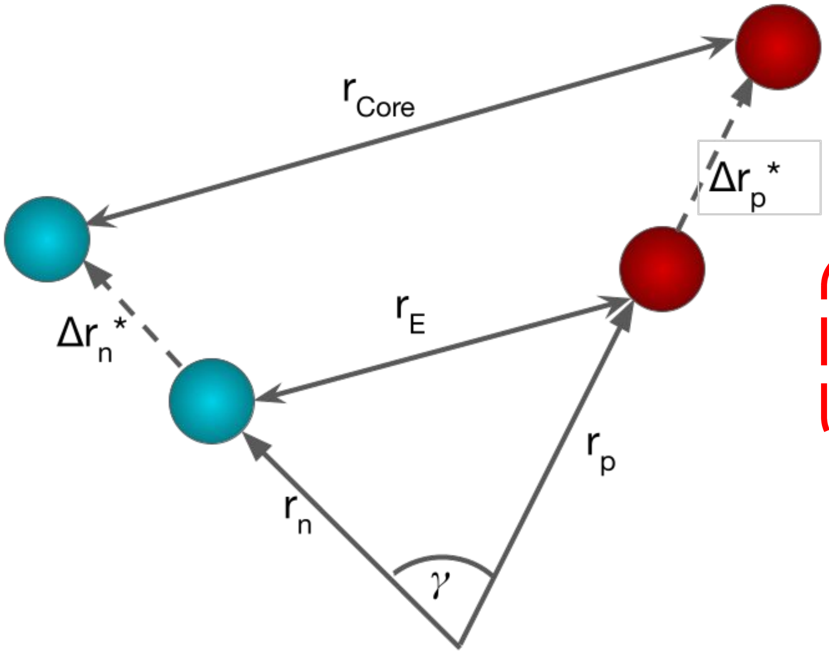

$$R = r_n/r_p,\ \ \Delta r_{core} = r_{core} - r_E,\ \ \Delta r_n^* = R \cdot \Delta r_p^*$$

$$\text{using:}\ \ c^2 = a^2 + b^2 + 2ab\cos\gamma$$

$$\Leftrightarrow \Delta r_{core}^2 = \Delta r_n^{*2} + \Delta r_p^{*2} + 2\Delta r_n^* \Delta r_p^* \cos\gamma$$

$$\boxed{\Rightarrow \Delta r_p^* = \frac{\Delta r_{core}}{\sqrt{R^2 + 1 - 2R\cos\gamma}} = \Delta r_n^*/R}$$