Chair of Galileo, from which, according to tradition, he gave lectures - Credits: Univ. of Padova - M. Pistore

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Analytical solutions to renormalization-group equations of neutrino oscillation parameters in matter

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The evolution of effective neutrino masses and mixing parameters in the ordinary matter can be characterized by a complete set of differential equations with respect to the matter parameter $a \equiv 2\sqrt{2}G_{\mathrm{F}}N_e E$, in analogy with the renormalization-group equations (RGEs) for running parameters. With some reasonable approximations, we find analytical solutions to the above differential equations, and obtain simple and compact formulas of all the effective oscillation parameters. Interestingly, the ratio of effective Jarlskog invariant $\widetilde{calJ}$ in matter to its counterpart $calJ$ in vacuum can be well described by $\widetilde{calJ}/calJ \approx 1/(\widehat{C}_{12}\widehat{C}_{13})$, where $\widehat{C}_{12} \equiv \sqrt{1 - 2\widehat{A}_* \cos 2\theta_{12} + \widehat{A}_*^2}$ with $\widehat{A}_* \equiv a \cos^2 \theta_{13}/\Delta_{21}$ and $\widehat{C}_{13} \equiv \sqrt{1 - 2A_{\mathrm{c}} \cos 2\theta_{13} + A_{\mathrm{c}}^2}$ with $A_{\mathrm{c}} \equiv a/\Delta_{\mathrm{c}}$.

Collaboration name

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