

Comenius University Bratislava

50 years from the foundation of Department of Nuclear Physics

Massive neutrinos in nuclear processes

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v physics was born in Tübingen



I have done a terrible thing. I invented a particle that canno

4th December 1930



As the bearer of these lines, to whom I graciously ask you to listen, will explain to you in more detail, how because of the "wrong" statistics of the N

and Li^o nuclei and the continuous beta spectrum, I have hit upon a desperate remedy to save the "exchange theorem" of statistics and the law of conservation of energy. Namely, the possibility that there could exist in the nuclei electrically neutral particles, that I wish to call neutrons, which have spin 1/2 and obey the exclusion principle and which further differ from light quanta in that they do not travel with the velocity of light. The mass of the neutrons should be of the same order of magnitude as the electron mass and in any event not larger than 0.01 proton masses. The continuous beta spectrum would then become understandable by the assumption that in beta decay a neutron is emitted in addition to the electron such that the sum of the energies of the neutron and the electron is constant.

> **Tagung in Tübingen** Lisa Meitner, Hans Geiger

Fundamental properties of v

of Matter (Fermion



we know

- 3 families of light (V-A) neutrinos: v_e, v_μ, v_τ • vs are massive: we know mass squared differences • Relation between flavor states and mass states
 - (neutrino mixing) only partially known

Claim for evidence of 0vββ

Lepton number violation



Breakdown of empirical conservation laws not protected by the gauge principle, such as the lepton number, the baryon number, the flavor changing process, CP violation are all expected. **Question is only the rate.**

R-parity breaking SUSY



 $W_{\mathbf{R}_{\mathbf{p}}} = \lambda_{ijk} L_i L_j E_k^c + \lambda'_{ijk} L_i Q_j D_k^c + \mu_i L_i H_2$

\Rightarrow see-saw mech.

Dirac-Majorana mass term



Measuring of v mass with β -decays

Detection of relic neutrinos

Reactor anti-v

Atmospheric v

TeV

PeV

Detection of DM particles





• NME for spin-dependent interaction of WIMPs • WIMP-nucleus cross section from two-nucleon currents from pion-exchange in the nucleus