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# Dynamical Pauli-Villars regularization

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**Statement of the Problem:** Quantum Field Theory (QFT) suffers from the problem of infinities. The simplest example is the vacuum energy density for scalar particles. In 1949 W Pauli and F Villars have suggested a phenomenological scheme for the regularization of such infinities. It introduces a set of auxiliary particles with very heavy masses. The absence of experimental observations of such particles resulted in the fact that so far the nature of auxiliary masses remains unclear. The purpose of this study is to find the mechanism which may lead to generation of such auxiliary masses and fields.

**Methodology & Theoretical Orientation:** It was assumed that space-time foam picture suggested first by J A Wheeler is capable of removing infinites in QFT. At very small distances topology of space-time fluctuates (space-time foam). The most natural description of such a picture is given by a gas of virtual wormholes, or, equivalently, of baby universes. At very small scales a baby universe may branch off and then joint onto our Universe. In classical gravity such processes are forbidden but they take place in quantum gravity as tunneling events. When a free particle propagates through the throat of such a virtual wormhole (i.e., it is captured by baby universe) it acquires the mass even if it was massless initially. The value of the mass is determined by the characteristic radius of the throat.

**Conclusion & Significance:** It was found that virtual wormholes generate an infinite sequence of auxiliary masses for all kinds of fields. The values of the auxiliary masses are very big and start from the Planck mass value ~ $10^{-5}$ g. This makes quantum field theory to be free of infinites. As a by-product it was found that external classical fields change the vacuum distribution of virtual wormholes (the intensity of topology fluctuations). This allows creating, from virtual wormholes, coherent structures which may work already as real wormholes.

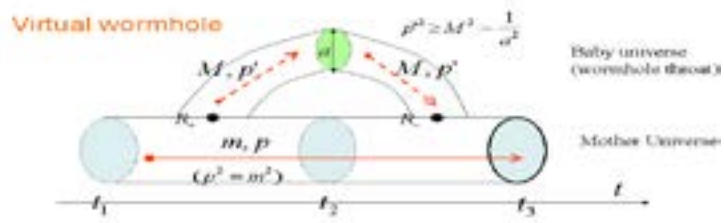


**Fig1** Particles go through wormhole throat and acquire masses $M \sim 1/a$. They form the auxiliary masses in the Pauli-Villars scheme. $R_c$ are points where baby branches off and joints onto Mother.

## Biography

E P Savelova has her expertise in Theoretical and Mathematical Physics. In 2009, she has completed her PhD in Theoretical Physics (Title of thesis is "Gas of wormholes as the model of dark matter" under the guidance of Prof. Kirillov AA). Between 2012-2016, she was the Associate Professor of Dubna State University and since 2016 she is the Associate Professor of Bauman Moscow State University. She has published 18 papers in reputed journals. Her basic works concern propagation of particles and fields on manifolds with complex topology (gas of wormholes) both in classical and quantum theory, modeling dark matter effects by a gas of wormholes, variation of speed of light by virtual wormholes. The most important result is the proof that virtual wormholes do remove divergences in quantum field theories.

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