Contribution ID: **6** Type: **Oral**

Experimental tests of quantum mechanics (Pauli Exclusion Principle and spontaneous collapse model)

Thursday, 14 October 2010 09:00 (20 minutes)

Experimental undergoing tests of the Pauli Exclusion Principle violation will be presented, together with future plans to measure the spontaneous emission of X rays predicted in collapse models.

We present a method of searching for possible small violations of the Pauli Exclusion Principle (PEP) for electrons, through the search for "anomalous" X-ray transitions in copper atoms, produced by "fresh" electrons (brought inside the copper bar by circulating current) which can have the probability to do the Pauli-forbidden transition to the 1 s level already occupied by two electrons. We describe, then, the VIP (VIolation of PEP) experiment, in data taking since 2006 at the Gran Sasso underground laboratories.
The goal of VIP is to test the PEP for electrons with unprecedented accuracy, down to a limit in the probability that PEP is violated at the level of 10-**29 - 10**-30, improving the previous limit by 3-4 orders of magnitude.
We report preliminary experimental results and briefly discuss some of the implications of a possible violation, together with future plans to gain other 2-3 orders of magnitude.
We will then present a project to use a similar experimental technique to measure the spontaneously emitted X rays predicted in the framework of collapse models (GRW theory, dynamical reduction models). Such models were put forward alternatively to the "standard" quantum mechanics' Schrodinger equation, followed by a "alla von Neumann" collapse of the wave-function, implementing a (nonrelativistic) dynamical reduction/collapse models, by modifying with a non-linear and stochastic terms the Schrodinger equation. Baring on the importance of this conceptually new model(s), it is of utmost importance to study its experimental consequences, where the predictions are diverging
from the standard equations, and to perform dedicated experiments to check it.
Today there are very few and far from complete experimental information. We aim to perform a feasibility study for a dedicated experiment to check the collapse models.

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Session Classification: Session Th - 1

Track Classification: Searches for symmetry violations