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寿命关联实驗的重要性*

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近年来量子理論的統計解释又为少数物理学者所质問．在极少数实驗工作中，我們可以提到 Janossy 在匈牙利領导进行的实驗工作．

因为量子理論探索微粒子的自然規律，自然而然地引入統計概念——所謂量子系綜．問題是量子系綜供給微粒子原則上完全的描述呢？还是它只供給原則上不完全的描述？这种描述是代表某种更基本的完全描述的上层构造．

更多的实驗工作将有助于解决这問題．考虑到近代物理实驗技术的发展，我以为串級衰变过程中上一代衰变的眞正寿命和下一代衰变的眞正寿命两者之間有无关联的現象是可以实驗研究的，而且很值得做实驗研究．令 t_1 和 t_2 代表一具体事例中上一代衰变 $A \to B$ 的眞正寿命和下一代衰变 $B \to C$ 的眞正寿命．在測量大量事例后用統計計算算出上一代衰变的平均寿命 $\langle t_1\rangle$，下一代衰变的平均寿命 $\langle t_2\rangle$，和接連两代衰变間的寿命关联系数

$$C = \frac{\langle(t_1 - \langle t_1\rangle)(t_2 - \langle t_2\rangle)\rangle}{\langle t_1\rangle\langle t_2\rangle}.$$

如有足够大量的事例，統計誤差也可以計算出，这样就能够确定地回答究竟存在寿命关联与否．按迄今为止的看法，量子理論預言两代衰变之間寿命不关联．这确定的預言可能为上述确定的实驗結果証实或者推翻．如果眞有寿命关联，因此迄今为止的量子系綜供給不完全的描述，它的实驗发現对今后理論进展必将有重大意义．

原子核的 $\beta-\beta$, $\beta-\gamma$ 或 $\gamma-\gamma$ 型的串級跃迁，可能有适宜做寿命关联实驗的，不必在此一一枚举．关于基本粒子的串級衰变我特别提起

$$K^+_{\pi 2} \to \pi^+ \to \mu^+$$

及

$$\pi^+ \to \mu^+ \to e^+$$

这儿实驗結果可能更可靠些，而理論推理也可能更清楚些．

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IMPORTANCE OF LIFE TIME CORRELATION EXPERIMENTS

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In recent years the statistical interpretation of quantum theory has again been questioned by some physicists. Among the very few experimental works done we may mention that led by Janossy in Hungary.

Because quantum theory aims at natural laws for microscopic particles, statistical concept (called quantum ensemble) is naturally involved. The question is whether the quantum ensemble affords in principle a complete description for the microscopic particles or it affords in principle only an incomplete description which represents the top structure of certain more fundamental and complete description for the microscopic particles.

It seems to me that more experimental work may help to decide this question. Thanks to modern development of experimental technique I think that experiments on the possible correlation between the actual life times of two successive decays can be made and may be well worth it. Let t_1 and t_2 denote, for a certain individual event, the actual life time of the parent dacay $A \rightarrow B$ and that of the daughter decay $B \rightarrow C$. After measuring a large number of individual events we can obtain by statistical calculation the average life time $\langle t_1 \rangle$ for the parent decay, the average life time $\langle t_2 \rangle$ for the daughter decay, and also the correlation coefficient

$$C = \frac{\langle (t_1 - \langle t_1 \rangle)(t_2 - \langle t_2 \rangle) \rangle}{\langle t_1 \rangle \langle t_2 \rangle}.$$

With a sufficient large number of events statistical errors can be calculated, so that a definite answer to the question of existence or non-existence of correlation can be made. Of course, according to present view, quantum theory predicts that no correlation between the successive life times should exist. This definite prediction can be verified or disproved by the above experiment which yields also definite result. If indeed life time correlation exists and therefore the present day quantum ensemble affords an incomplete description for microscopic particles, then its experimental discovery may prove to be very important for further theoretical development.

It is unnecessary to mention the very many cascade nuclear transitions of $\beta - \beta$, $\beta - \gamma$ or $\gamma - \gamma$ types that may be used for the above purpose. Concerning the cascade decay of elementary particles we mention specially the cases of $K^+_{\pi 2} \rightarrow \pi^+ \rightarrow \mu^+$ and $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ where experimental results may be more reliable and where theoretical reasoning may be less ambiguous.