Samoil as a "Schrödinger Guest Professor" in Vienna

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Celebrating Neutrinos:
Colloquium in Honor of Prof. S. Bilenky
at the Occasion of his 90th Birthday
May 23, 2018

universität wien

List of "Schrödinger Guest Professors," part 1

1970 Henry Primakoff
1971 -
1972 Andrzej Trautman
1973 Tsung-Dao Lee
1974 Elliott Lieb
1975 Sidney D. Drell
1976 Tosio Kato, John C. Slater (?), Barry Simon
1977 Yvonne Choquet-Bruhat
1978 A.S. Wightman, A. Martin, A. Kossakowski
1979 Victor Weisskopf, Rudolf Haag
1980 Chen Ning Yang, John S. Bell
1981 Elliott Lieb, Charles Angas Hurst
1982 Huzihiro Araki
1983 Barry Simon, Roberto Peccei
1984 Heinrich Leutwyler, Julius Wess
1985 Peter Carruthers
1986 George Mackey

List of "Schrödinger Guest Professors," part 2

1987 - (?)
1988 Jogesh C. Pati
1989 Hervé Kunz, Mikhail A. Shifman
1990 Samoil M. Bilenky
1991 Chris Quigg
1992 Detlev Buchholz, Elliott Lieb
1993 Roman Jackiw
1994 Lev Okun
1995 Stanley Deser
1996 James D. Bjorken
1997 Peter van Nieuwenhuizen
1998 John Ellis
1999 Peter Zerwas
2000 John F. Gunion
2001 Jean Zinn-Justin
2002 Frank Wilczek

List of "Schrödinger Guest Professors," part 3

2003 Valentine I. Zakharov
2004 Samoil M. Bilenky
2005 Nicola Cabibbo
2006 Wolfgang Hollik
2007 Alexei Yu. Smirnov
2008 Eduardo de Rafael
2009 Jürg Gasser
2010 Andrzej Buras
2011 Georg Raffelt
2012 Stanley Brodsky
2013 Matthias Jamin
2014 Aneesh Manohar
2015 John Donoghue
2016 Iain Stewart
2017 Christopher T. Sachrajda

Neutrino counting at the Z peak

Neutrino counting via $\Gamma(Z^0 \to \text{neutrinos})$

SM: Z^0 width for one neutrino $\equiv \Gamma_0 = \frac{G_F M_Z^3}{12\sqrt{2}\pi}$

$n_{\rm exp} \equiv \Gamma(Z^0 \to \text{neutrinos})/\Gamma_0$

Rev. Part. Phys.: $n_{\rm exp} = 2.984 \pm 0.008$

R. Bertlmann, H. Pietschmann

The decay of the neutral intermediate boson

PR D15 (1977) 683

J. Ellis, M.K. Gaillard, G. Girardi, P. Sorba

The physics of intermediate vector bosons

Ann. Rev. Nucl. Part. Sci. 32 (1982) 443

Neutrino counting at the Z peak including sterile neutrinos

C. Jarlskog

Neutrino counting at the Z peak and righthanded neutrons

PLB 241 (1990) 579

With sterile neutrinos $n_{\rm exp} < 3$

S.M. Bilenky, W. Grimus, H. Neufeld

A lower bound on the "number of neutrino species"

PLB 252 (1990) 119

Neutrino counting at the Z peak including sterile neutrinos

N right-handed neutrino fields ν_{Ri}, $N \geq n = 3$
Mass eigenfields of Majorana nature:

$$\nu_{L\alpha} = \sum_{a=1}^{N} U_{\alpha a}\, \omega_{La}$$

Special case: $N = 4$

$$n_{\rm exp} = 3 - \sigma^2\,(1 - R_{44}) - 2\sigma\,(1 - R_{14}) \quad \text{with} \quad \sigma = \sum_{\alpha=e,\mu,\tau} |U_{\alpha 4}|^2$$

Largest possible deviation from 3 for $m_4 \geq M_Z \Rightarrow R_{14} = R_{44} = 0$
$(R_{14}(m_1 = m_4 = 0) = R_{44}(m_1 = m_4 = 0) = 1)$

A lower bound on $n_{\rm exp}$

Input:

- Muon decay: $G_\mu^2 = G_F^2 \left(1 - |U_{\mu 4}|^2\right) \left(1 - |U_{e4}|^2\right)$
- Nuclear beta decay: $|V_{ud}|^2 / \left(1 - |U_{\mu 4}|^2\right)$
- K_{e3} decay: $|V_{us}|^2 / \left(1 - |U_{\mu 4}|^2\right)$
- $\Gamma(\pi^+ \to e^+ \nu_e) / \Gamma(\pi^+ \to \mu^+ \nu_\mu) \propto \left(1 - |U_{e4}|^2\right)) / \left(1 - |U_{\mu 4}|^2\right)$
- $G_{\tau\mu}^2 = G_F^2 \left(1 - |U_{\mu 4}|^2\right) \left(1 - |U_{\tau 4}|^2\right)$ or $G_{\tau e}^2 = G_F^2 \left(1 - |U_{e4}|^2\right) \left(1 - |U_{\tau 4}|^2\right)$

Happy birthday, Samoil

from

Herbert Pietschmann

Gerhard Ecker

Helmut Neufeld

and myself