Kazumi Maki

Kazumi Maki, one of the most prolific solid-state theorists of the last five decades, passed away on the 10th of September 2008. We loose a great scientist, a very original and lovable personality, and many of us loose a good friend. Kazumi was born on January 27 1936. His wife Masako remembers that “he was very proud to have the same birthday as his beloved Mozart”. He spent most part of his childhood in Kyoto except during World War II when the family was forced to live in the countryside. He studied theoretical particle physics at the University of Kyoto and joined Yukawa’s group for the Ph. D. thesis, which he finished in 1964. A three-year postdoctoral period followed at several places both in Northern America (University of Chicago, UC Berkeley, UC La Jolla, University of Toronto) and in Europe (Orsay and IBM Rüschlikon). He became professor at the Tohoku University in Sendai at the early age of 31, a position kept until 1974. He traveled frequently during this period, including many visits to Orsay, where he met Pierre-Gilles de Gennes. In 1974 he finally exchanged the (too) rigidly structured Japanese society for Californian freedom, by accepting a professorship at the University of Southern California. He remained a USC College professor of physics and astronomy until his death.

Apart from three early papers on quantum field theory, the research of Kazumi Maki was focussed on solid-state physics. He made substantial contributions to several fields, above all to superconductivity. About half of his roughly 500 publications deal with superconductivity. They appeared in two distinct periods, an early “BCS period” (1961-1972) and a late “HTS period” (1991-2008). When he started to work on superconductivity, the theory of Bardeen, Cooper and Schrieffer was still quite new and offered therefore a rich playground for a young researcher. Kazumi Maki became quickly a virtuoso in BCS theory, or more precisely in the field-theoretic formalism (developed by Gor’kov in 1958). His most famous contribution during the early period is probably the discovery of an anomalous enhancement of the normal electrical conductivity just above the critical temperature due to the presence of superconducting fluctuations (1968). This effect, which has to be added to the direct contribution of superconducting fluctuations (discovered essentially at the same time by Aslamazov and Larkin), received the label Maki-Thompson term (subsequently to the 1970 paper of Dick Thompson, who later on became Maki’s colleague at USC). It is interesting to note that Maki’s very first paper on high-temperature superconductors deals with fluctuation conductivity and is coauthored by Dick Thompson (1991). The HTS period was in other respects a revival of Maki’s BCS period. At the very beginning of his career he had extensively studied the problem of pair breaking and the concomitant zero gap superconductivity (he contributed a well-known review paper to Ronald Parks’ two volumes on superconductivity (1969)). With the advent of high-temperature superconductors and the growing evidence for d-wave pairing the problem received a new twist, as non-magnetic impurities produce much stronger effects in an unconventional superconductor (with line nodes) than in a conventional (s-wave) superconductor. Similarly, the vortex lattice, a favorite object of study for Maki during the BCS period, had to be revisited in the case of superconductors with d-wave, p-wave or even f-wave symmetry.

The intermediate time span (1973-1990) had two parts, a ^{3}He period and a 1D period. The ^{3}He period was launched by the discovery of a new phase in this fermionic quantum liquid below 2.7 mK by Osheroff, Richardson and Lee (1972) and its identification as an anisotropic (p-wave) superfluid. Maki immediately sharpened his pencil (see below) and worked on spin waves, zero sound, fourth sound, NMR, orbital modes. Superfluid ^{3}He became his main research field during the subsequent 12 years, and he shared his insight with several Ph. D. students and senior collaborators (Marie-Thérèse Béal-Monod, Robin Bruinsma, Roland Combescot, Hiromichi Ebisawa, Chia-Ren Hu, Giorgi Kharadze, Hagen Kleinert, Pradeep Kumar, Doug Mills, Mikio Nakahara, Y. R. Lin-Liu, Nils Schopohl, Toshihiko Tsuneto, Dieter Vollhardt, Xenophon Zotos). Maki showed that the anisotropic superfluid exhibits various types of solitons in the form of specific spatial textures of the order parameter.

The 1D period was initiated in the late seventies by three major breakthroughs, the observation of a highly nonlinear transport at the two charge-density wave transitions in $NbSe_3$ by Pierre Monceau and Nai Phuan Ong (1976), the preparation of highly conducting polymer films by Alan Heeger, Alan MacDiarmid and Hideki Shirakawa (1977) together with the arrival of the famous SSH Hamiltonian (Su, Schrieffer and Heeger, 1980), and the successful synthesis of the Bechgaard salts, a new class of organic quasi-one-dimensional compounds, with a panoply of different phases, including superconductivity and spin-density waves (Klaus Bechgaard *et al.*, Denis Jérôme *et al.*, 1980). Kazumi Maki worked intensively on many issues related to these materials, including the intricate transport involving charge-density wave motion and - in a close collaboration with Attila Virosztek - the thermodynamics of field-induced spin-density waves in the Bechgaard salts. His 1980 paper on the "Continuum model for solitons in polyacetylene" (with H. Takayama and Y. R. Lin-Liu) is his most cited publication. Maki's interest was usually triggered by a new experiment, but he also gave important contributions to purely theoretical questions, especially during the 1D period. Thus, while he applied successfully the soliton concept to superfluid ^{3}He, to discommensurations in charge-density wave condensates, to bond-alternation defects in polyacetylene and to kink modes in one-dimensional XY ferromagnets, he also worked intensively on canonical soliton-bearing models. He published a series of four papers on the "Quantum statistical mechanics of extended objects" (with Hajime Takayama), two papers on the "Path integral method of soliton-bearing systems" (with Takashi Miyashita) and a paper on the "Classical sine-Gordon limit of Bethe-ansatz thermodynamics" (alone), among others.

In the late eighties Kazumi Maki was still fascinated by quasi-one-dimensional materials, in particular by the Bechgaard salts, so much that the High-T_c fever outbreak in 1987 is not visible in his publication list. Even when he finally became very active in the High-T_c arena, he did not forget the density waves, but rather married them with superconductivity. In Maki's theory (initially worked out together with Hyekyung Won) the "pseudogap phase" is associated with an unconventional spin-density wave. Correspondingly, the underdoped part of the superconducting dome is identified with Gossamer superconductivity, a concept introduced before by Bob Laughlin as a fragile superconducting state of a weakly doped Mott insulator (for a Hubbard-type model) and reinterpreted by Kazumi Maki as a (weak) d-wave superconductor in the background of a strong d-density wave (using a phenomenological mean-field theory). This reduction of a system of strongly correlated electrons to a mean-field theory of two partially coexisting order parameters reflects Maki's profound believe that with a Hubbard-type Hamiltonian the (bare) energy scales are too large compared to the relevant physical scales (gap parameter, critical temperature) to allow a trustable solution. At the ECRYS workshop 2005 he compared such an endeaver with the attempt at solving the standard model of particle physics.

I met Kazumi Maki for the first time at a workshop on Solitons and Condensed Matter Physics in Oxford (September 1977), where he presented a talk on textures in superfluid ^{3}He. I did not have the occasion to discuss with him, but I do remember having asked my neighbor in the lecture hall which language Kazumi was using. Five years later we shared an office in Peter Fulde's group at MPI in Stuttgart. The first curious thing I noticed was the action Kazumi undertook after he sat down at his desk in the early morning. He sharpened five pencils, put them well-aligned on the desk and then started to fill page after page with beautifully written equations. We became quickly good friends and had not only a close collaboration on conducting polymers but also in music. I realized only later that before the pencil ceremony Kazumi had usually already practiced the violin during an hour. His favorite composers were Schubert — he not only loved his sonatinas for violin and piano, but also liked to sing the Lieder — and, of course, Mozart.

The originality of Kazumi Maki was not limited to a few funny quirks, but deeply rooted in his personal independence, which was reflected in his immunity to other people's opinions and in his mistrust of authorities and social norms. The Californian way of life helped him to keep his principles, and even on the Santa Monica freeway, which very often resembles a strongly correlated system with a few holes, he was able to surge acrobatically from hole to hole, notwithstanding the white faces of his passengers. We will miss Kazumi, but we will not forget his wonderful personality.

Fribourg, 5^{th} of October 2008

Dionys Baeriswyl