# Current work in string theory

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*Quantum String Theory: Proceedings of the Second Yukawa Memorial Symposium.* Nishinomiya, Japan, October 23-24, 1987/Eds. N. Kamamoto and T. Kyogo. Springer-Verlag, Berlin; Heidelberg; New York; London; Paris; Tokyo; 1988. 147 pp. (Springer Proceedings in Physics. V. 31).

In recent years, Springer-Verlag have been widely and systematically publishing Proceedings of various conferences and schools in the form of individual books-collections of articles. They are acquiring considerable significance in the present-day system of scientific information, approaching in the speed of publication to the review and even the ordinary scientific journals. Such collections of articles have become particularly popular in the field of string theory and mathematical physics to which Springer have been devoting particular attention.

The collection of articles under review is dedicated to the memory of the remarkable Soviet theoretical physicist, Vadim Knizhnik. By his 25th year, Vadim managed to create an entire new direction in the currently rapidly developing string theory, and this direction associated with complex and algebraic geometry remains as of now the most fruitful and promising one. The collection is based on the materials of the Second Yukawa Memorial Symposium held in the city of Nishinomiya in Japan (Fall 1987)–the last one in which V.G. Knizhnik was fated to participate. At the symposium, he reported on one of his most elegant papers devoted to the calculation of chiral determinants on Riemann surfaces. This calculation is an outstanding example of the combination of physical thinking with the most modern mathematical apparatus, a confident stand at the boundary between the permissible and the impermissible in mathematical physics, the errorless intuition which at no point permitted him to step over this invisible line. These features, probably the most unusual ones in Vadim's talent, are easily discernible in any of his papers. The result on chiral determinants included in the collection has now become a classic one and has been reproduced by different methods and by different people; the methods of bosonization on Riemann surfaces utilized in the derivation are being applied more and more widely, but the original presentation remains as before one of the best ones, and attracts one by the precise positioning of emphases and by clarity.

The collection also contains a brief, but very important, note by A.A. Belavin which points out the connection between the recently discovered (1987) W-algebras of A.B. Zamolodchikov and the well-studied by then Kac-Moody algebras. This connection now formulated in terms of the so-called coset-constructions was somewhat later studied in detail by S.L. Luk'yanov and V.A. Fateev and other authors, however the note of A.A. Belavin remains very topical even now.

The remaining lectures included in the collection belong to Western participants in the Symposium. Two long review articles by H. Ooguri and N. Sakai concerning multiloop calculations in the first-quantized string theory and by A. Jevicki on the Witten second-quantized theory more often called string field theory occupy the greater part of the volume. Jevicki's review is based on his well-known paper together with D. Gross in which the general ideas concerning the field theory of open strings presented by E. Witten are translated into the concrete language of formulas which allow analysis and serious discussion. An approach to string field theory that differs somewhat from the Witten approach is being developed by a group of physicists from Kyoto University. A condensed presentation of their results is given in a short lecture by one of the members of the group–H. Hata.

The long review by H. Ooguri and N. Sakai mentioned above contains fairly elementary information concerning string theory on Riemann surfaces which is basically associated with the Schottky parametrization. Timid attempts are also made to extend these standard results to the case of strings embedded in curved space-time. In such a situation the Polyakov functional integral reduces not to free fields on a Riemann surface, but to interacting fields–the so-called nonlinear conformal sigma-model. Sigma-models appearing in string theory are a particular example of general two dimensional conformal theories. Multiloop calculations in string theory of a general form reduce to an analysis of conformal theories on Riemann surfaces. An example of such an analysis in the simple case when the Riemann surface is a torus is given in the brief not by T. Eguchi where differential equations concerning single-loop characters of the Ising model are derived and solved. Among the advantages of this generalization one can include the use of hyperelliptic coordinates for the parametrization of the torus modules, i.e., coordinates which can be utilized also in a more general situation.

All these materials from the "leading edge" of string science aimed at specialists are preceded by two introductory lectures of L. Brink and T. Yoneya. L. Brink recalls the initial definitions of different string models and the derivation of their fundamental properties–the spectral and spin structure of string excitations–in the simplest and clear light-cone gauge. T. Yoneya devoted his lecture to the property of strings which is of the greatest importance for applications to the theory of unification of interactions–the appearance of the Yang-Mills gauge symmetries and the

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general theory of relativity in the effective low-energy theory obtained from strings. Remarks of a very general nature are also quoted concerning the change implied by strings in the concepts of space and time at ultrasmall distances.

The collection consisting of articles by enthusiasts of string theory is concluded by an article of a somewhat different nature. It is written by H. Nielsen and N. Brene and, as everything which H. Nielsen does, is completely non-standard and even unexpected. Starting with an instructive discussion of the position of string theory in modern natural science and comparing our thoughts concerning strings with the thoughts of ancient Greek thinkers concerning the principle of gauge invariance, the authors turn to the possibilities of relating structural concepts to modern experiments. In order to emphasize the complete absence of such a relationship, they put forward and tried to lay a foundation for the idea of the independence of the "low-energy" physics (they have in mind the teraelectron-volt region, i.e., the energy of the future supercolliders) from the concrete structure of the "theory of everything", the role of which it is proposed that the string theory should play. Undoubtedly, to many specialists this thought should appear shocking, but, who knows, perhaps in it there is concealed some grain of truth, and, possibly, it is fated to acquire a no less entrancing appearance, than the modern string theory which also appeared at one time in a not so attractive and objectionless form.

On the whole the collection of articles under review reflects the situation as it existed in string theory at the end of 1987. The material contained in it remains timely even today.