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HOW TO QUANTIZE ANOMALOUS THEORIES?

STRING WITH QUENCHED CONFORMAL ANOMALY

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HOW TO QUANTIZE ANOMALOUS THEORIES?
STRING WITH ~~ANNEAL~~quenchED CONFORMAL ANOMALY

To consider degrees of freedom connected with the anomalies as ~~anneal~~quenched random coupling in spin glasses is suggested. Some critical indices for such string model are calculated.

Yerevan Physics Institute
Yerevan 1989

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Д.Б.СААКЯН

К ВОПРОСУ О КВАНТОВАНИИ АНОМАЛЬНЫХ ТЕОРИЙ. СТРУНА С ЗАМОРОЖЕННОЙ КОНФОРМНОЙ АНОМАЛИЕЙ

Предлагается рассматривать степени свободы, связанные с аномалией, аналогично замороженным случайным константам взаимодействия в спиновых стеклах. Вычисляются критические индексы для такого типа струны.

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In the usual quantum field theory and statistical mechanics we work with degrees of freedom of equal significance X_i and define mean values of as

$$\langle G \rangle = \int \Pi dX_i e^{-S(X)} G(X) \Big/ \int \Pi dX_i e^{-S(X)} \qquad (1)$$

In spin glasses we have ~~annealed~~ quenched field J and usual field X

$$\langle G \rangle = \int \Big[\int dx G(x) e^{-S(x,J)} \Big/ \int dx e^{-S(x,J)} \Big] dJ \Big/ \int dJ , \qquad (2)$$

where dJ is some measure.

Is it possible for the definition (2) to appear in natural manner in quantum field theory?

In anomalous theories we encounter a situation when there are degrees of freedom of different significance. The problems of quantization, perhaps, are consequences of definition (1).

I suppose to consider appearance of anomaly as symmetry breaking in phase transitions. We can think that our system elected particular vacuum (after symmetry breaking) defined by J . Then, physical observables must be defined after averaging

the values of Green functions over particular vacuums J .
Such approach agrees with usual considerations of d2 Ising model. If we take definition (1), we'll have no magnetization and besides overcount statistical sum Z twice. Our situation resembles in some sense breakdown of quantum coherence in black hole radiation (Hawking effect). In this case G are probabilities ($\sim$ amplitude squares), J are states in the black holes. Remember, that strings are d2 gravitation. And the last argument is that in our definition the amount of the degrees of freedom is the same both in classical and quantum theories. Perhaps, this fact is more important than the problems with possible breaking of some symmetries in definition (2).

The action of the boson string is [1]

$$S = \int \sqrt{g}\, d_\alpha X^\mu\, d_\beta X^\mu g^{\alpha\beta} . \tag{3}$$

String with the action (3) according to definition (1) was quantized in the space dimension $d \leqslant 1$ [2,3] .

In Refs [2,3]

$$\langle G \rangle \sim \int d\tau\, dP\, \Delta(\tau)\, e^{-\frac{26}{48\pi} S_L(\hat{g}(\tau), P)} \int dx^\mu e^{-S} G \tag{4}$$

τ are Teichmuller parameters, P - conformal factor, $\Delta(\tau)$- determinant, S_L - Liouville action.

Let us by analogy with (2) define

$$\langle G \rangle \sim \int d\tau\, dP\, \Delta(\tau)\, e^{-\frac{26}{48\pi} S_L(\hat{g}(\tau), P)} \left[\frac{\int dx^\mu e^{-S} G}{\int dx^\mu e^{-S}} \right] \tag{5}$$

$\langle 1 \rangle = 1$

We consider surfaces with fixed topology. For the case of sphere τ is absent. We can calculate Hausdorf dimension.

We are interested in

$$G = \left\langle \int \sqrt{g}\, d^2\xi_1 \int \sqrt{g}\, d^2\xi_2\, X^\mu(\xi_1) X^\mu(\xi_2) / \left(\int \sqrt{g}\, d^2\xi \right)^2 \right\rangle \tag{6}$$

G_1 is G for definition (4) and G_2 for definition (5).

By means of replica trick

$$G_2(d) = \lim_{n \to 0} \frac{G_1(nd)}{n} \tag{7}$$

We obtain that Hausdorf dimension d_H for all d equals d_H for d=0 Polyakov string, $d_H = 4$.

As in the case of spin glasses, the properties of the model (5) resemble those of the model (4) for d=0. In particular, for surface distribution as a function of the area S, we have (calculations are the same as in [4]):

$$\rho(S) \sim S^{-3,5} \tag{8}$$

Thus we predict $\gamma = -1/2$.

In [5] for the planar surfaces without spikes on the rigid lattice there was founded a continuous limit in the phase transition point, and $\gamma \approx 0.25$, $d_H \approx 4$. Authors [5] calculated γ by means of $\rho(S)$. This method for γ evaluation is incorrect, because in critical point small values of are essential, and for such surfaces the critical degree changes from the value -3.5.

It is desirable to repeat numerical simulation of [5] for other $d < 8$, where we expect a similar phase transition.

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