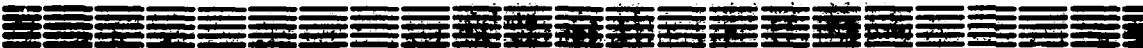


200109365

Preprint YERPHI-1263(49)-90 .

**ԵՐԵՎԱՆԻ ՖԻԶԻԿԱՅԻ ԻՆՍՏԻՏՈՒՏ**  
**ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ**  
**YEREVAN PHYSICS INSTITUTE**



**D. B. SAHAKIAN**

**THE ENTROPY OF THE VACUUM CHOOSING IN PHASE TRANSITIONS**

**ЦНИИатоминформ**  
**ЕРЕВАН-1990**

## Դ.Բ.ՍԱՀԱԿՅԱՆ

### ՎԱԿՈՒՈՒՄԻ ԸՆՏՐՄԱՆ ԷՆՏՐՈՊԻԱՆ ՖԱԶԱՅԻՆ ԱՆՑՄԱՆ ԺԱՄԱՆԱԿ

Գիտություն է վիճակագրական գումարի լոգարիթմի  $\ln z$ -ի սահմանային արժեքի  $\ln z$ -ի անսահմանության ձգտող հանգույցների թվի : Ֆազային փոփոխության կետով սեղանի վրա գոյություն ունի գրոյախան ատոմիզացիոն արգում (թիշր) : Տեսագրությամբ ստեղծվելով, որ որոշված են Թորի տպագրությունով ցանցերի վրա, այդ թիշրը հավասար է  $\ln z$ , որ  $z$ -ն իսխատված ատոմիզացիոն թվի կորզն է :

Երևանի Ֆիզիկայի ինստիտուտ  
Երևան 1990

Д. Б. СААКЯН

ОБ ЭНТРОПИИ ВЫБОРА ВАКУУМА ВО ВРЕМЯ ФАЗОВЫХ ПЕРЕХОДОВ

Рассматривается асимптотическое разложение логарифма статистической суммы  $\ln Z$  по стремящемуся к бесконечности  $N$ -числу узлов решетки. Имеется скачок члена с нулевой степенью при прохождении через точку перехода. В изученных случаях модели на решетках с топологией тора скачок оказывается равным  $\ln Q$ , где  $Q$  — порядок нарушенной группы симметрии.

Ереванский физический институт

Ереван 1990

D. B. SAHAKIAN

ON THE ENTROPY OF THE VACUUM CHOOSING IN PHASE TRANSITIONS

The asymptotic expansion of the statistical sum logarithm  $\ln Z$  over the number of lattice sites  $N$  tending to infinity is considered. The zero-power term makes a jump when passing through the transition point. In the models investigated, the jump on the sites with a topology of a torus turned out to be  $\ln Q$ , where  $Q$  is the order of the broken symmetry group.

Yerevan Physics Institute

Yerevan 1990

Among many interesting phase transition properties there is one which is general for most of them (independent of the order of transition). This is a system's property to choose the vacuum itself, when passing through the transition point.

The choice for a manifestation of this effect is the purpose of the present work.

Note, that a phase transition occurs only within an infinite volume of lattice. That is why we are considering the asymptotic expression of free energy (in temperature units):

$$nz = Nf_0(B) + \dots f_1(B) + o(1) \quad (1)$$

The expression in principle could include other terms (depending on the boundary condition) with whole powers  $N^{1/d}$ , as well as (in the second-order transition point on a lattice or for models on a random lattice) terms proportional to  $\ln N$ .

We are usually interested in the behaviour of  $f_0(B)$ . This is a continuous function over  $B$ , and its derivatives (depending on the order of transition) are singular.

When considering the Ising model on a torus, solved by Onsager (for a finite lattice (see Ref.[1]), we find that

$$\lim_{\varepsilon_1 \rightarrow 0} f_1(B_c + \varepsilon_1) - \lim_{\varepsilon_2 \rightarrow 0} f_1(B_c - \varepsilon_2) = \ln 2 \quad (2)$$

This is in an agreement with the simplest expression which could be expected. If the  $Q_2$ -order symmetry group is broken up to the  $Q_1$ -order subgroup, then it is reasonable to expect that

$$\Delta f_1(B) = \ln Q_2 / Q_1 \quad (3)$$

By the numerical method of Ref.[2] we have investigated the Potts model with  $Q=3$ ,  $Q=5$  on two-dimensional lattices with sizes up to  $20 \times 20$ .

Within the limits of the accuracy of our numerical experiment ( $\sim 30\%$  after 100,000 iterations) the value of the jump  $\Delta f_1(B_c)$  agreed to  $\ln 3$  and  $\ln 5$  (first-order and second-order transitions, respectively).

The same result,  $\ln 2$ , was obtained also for the  $d=3$  Ising model (the lattice size was up to  $7^3$ ).

Making use of the results of Ref.[3] we have analytically calculated the values of  $f_1(B)$  for the Ising model on a random lattice with a topology of a sphere or a torus. These are third-order transitions. In case of a spherical topology the effect vanishes unexpectedly:

$$\lim_{\varepsilon \rightarrow 0} f_1(B_c + \varepsilon) - f_1(B_c - \varepsilon) = 0, \quad (4)$$

while in case of a torus it appears again:

$$\lim_{\varepsilon \rightarrow 0} f_1(B_c + \varepsilon) - f_1(B_c - \varepsilon) = \ln 2. \quad (5)$$

The values of  $f_1(B)$  for the Ising model on hard lattices with a topology of a sphere or a pretzel (numerically) and on the random lattices of  $g=2,3$  order are being calculated.

It would be interesting to investigate the problem of universality as well as the dependence of this effect on the lattice defects.

An analogous effect can be expected in stochastic phenomena. At any rate, if in case of doubling (duplication???) of the cycle periods we define  $z$  as the maximal inflation of the primary differential uncertainty, then the abrupt change agrees again to (3).

Finally, this effect could be essential in case of breaking of the local symmetry group. In this situation (spin glass?) it may turn out that  $\ln Q_2/Q_1 \sim N$ .

In conclusion the author thanks H.M.Babujian, D.V.Bulato... V.C.Dotsenko and S.G.Matinyan for helpful discussions.

### References

1. Попов В.М. Континуальные интегралы в квантовой теории поля и статфизике. М: Атомиздат, 1976.
2. Sogo K., Kimura N., Phys. Lett., 1986, v.115A, p.221.
3. Казаков В.А. Письма в ЖЭТФ, 1986, т.44, вып.3, с.105.

The manuscript was received May 10, 1990

Д. Б. СААКЯН

ОБ ЭНТРОПИИ ВЫБОРА ВАКУУМА ВО ВРЕМЯ ФАЗОВЫХ ПЕРЕХОДОВ

(на английском языке, перевод Г. А. Папяна)

Редактор Л. П. Мукаян

Технический редактор А. С. Абрамян

---

Подписано в печать 14/XII-90  
Офсетная печать. Уч. изд. л. 0,4  
Зак. тип. 316

Формат 60×84×16  
Тираж 299 экз. Ц. 4 к.  
Индекс 3649

---

Отпечатано в Ереванском физическом институте  
Ереван-36, ул. Братьев Алиханян 2.

**The address for requests:  
Information Department  
Yerevan Physics Institute  
Alikhanian Brothers 2,  
Yerevan, 375036  
Armenia, USSR**

**ИНДЕКС 3649**



**ЕРЕВАНСКИЙ ФИЗИЧЕСКИЙ ИНСТИТУТ**