

IC/69/121

INTERNATIONAL ATOMIC ENERGY AGENCY

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

INFORMAL MEETING  
ON RENORMALIZATION THEORY

25 - 29 August 1969

(SUMMARIES)

MIRAMARE - TRIESTE

September 1969



# RENORMALIZING THE ENERGY-MOMENTUM TENSOR

C. CALLAN

Institute for Advanced Study, Princeton, N.J., USA,

S. COLEMAN

Harvard University, Cambridge, Mass., USA,

R. JACKIW

MIT, Cambridge, Mass., USA.

(Presented by R. Jackiw)

Contrary to common belief, the matrix elements of the energy-momentum tensor are not in general finite in renormalized perturbation theory, regardless whether this tensor is evaluated from the canonical formula

$$\theta^{\mu} = \sum_r \frac{\delta}{\delta \varphi_r} \partial^{\nu} \varphi_r - g^{\mu\nu} \mathcal{L}$$

or from the symmetric formula of Belinfante. It is shown that for all renormalizable theories it is possible to add to  $\theta^{\mu\nu}$  an additional term, which does not destroy the symmetries and conservation properties of  $\theta^{\mu\nu}$ , which does not contribute to the Poincaré generators, but which removes the divergences in renormalized perturbation theory, thus yielding a finite energy-momentum tensor. For example, for the scalar  $\lambda \varphi^4$  theory, the addition is proportional to  $(\partial^{\mu} \partial^{\nu} - \square g^{\mu\nu}) \varphi^2$ .

The modified tensor  $\theta^{\mu\nu}$  has the additional interesting property that in terms of it the dilation and conformal currents  $D^{\mu}$  and  $K^{\mu\nu}$ , respectively, have the simple form

$$D^{\mu} = X_{\nu} \theta^{\mu\nu}$$

$$K^{\mu\nu} = X^2 \theta^{\mu\nu} - 2X^{\nu} X_{\alpha} \theta^{\alpha\mu}.$$

It is noted that in all renormalizable theories dilation invariance implies conformal invariance, while for arbitrary theories a condition is exhibited which is necessary and sufficient for dilation symmetry to imply conformal symmetry<sup>1), 2)</sup>.

#### REFERENCES

- 1) C. Callan, S. Coleman and R. Jackiw, in preparation.
- 2) The connection between dilation symmetry and conformal symmetry has been previously established in slightly weaker form by G. Mack and Abdus Salam, Ann. Phys. (N. Y.) 53, 174 (1969); and D. J. Gross and J. Wess, in preparation.