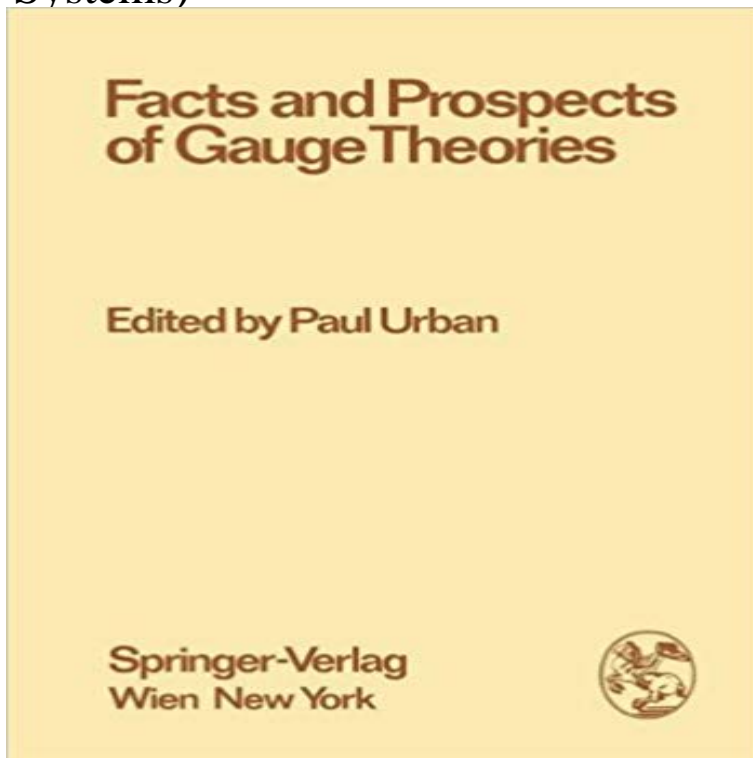


# Facts and Prospects of Gauge Theories: Proceedings of the XVII. Internationale Universitätswochen für Kernphysik 1978 der Karl-Franzens-Universität ... February - 3rd March 1978 (Few-Body Systems)



These lectures concern the properties of topological charge in gauge theories and the physical effects which have been attributed to its existence. No introduction to this subject would be adequate without a discussion of the original work of Belavin, Polyakov, Schwarz, and Tyupkin [1], of the beautiful calculation by 't Hooft [2,3], and of the occurrence of 8-vacua [4-6]. Other important topics include recent progress on solutions of the Yang-Mills equation of motion [7,8], and the problem of parity and time-reversal invariance in strong interactions [9] (axions [10,11], etc.). In a few places, I have strayed from the conventional line and in one important case, disagreed with it. The important remark concerns the connection between chirality and topological charge first pointed out by 't Hooft [2]: in the literature, the rule is repeatedly quoted with the wrong sign! If  $Q_5$  is the generator for Abelian chiral transformations of massless quarks with  $N$  flavours, the correct form of the rule is  $\langle \text{out} | Q_5 | \text{in} \rangle = -2N \langle \text{out} | \text{topological charge} | \text{in} \rangle$  where  $\langle \text{out} | Q_5 | \text{in} \rangle$  means the out eigenvalue of  $Q_5$  minus the in eigenvalue. The sign can be checked by consulting the standard WKB calculation [2,3], rotating to Minkowski space, and observing that the sum of right-handed chiralities of operators in a Greens function equals  $-\langle \text{out} | Q_5 | \text{in} \rangle$ . The wrong sign is an automatic consequence of a standard but incorrect derivation in which the axial charge is misidentified

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