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The thermodynamics of quantum Yang-Mills theory. Theory and applications. (English)

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Theories based on gauge invariance beyond the simple $U(1)$ gauge theory of QED have proved successful in describing modern particle physics. Yang and Mills in 1954 were the first to propose the group $SU(2)$ as the non-Abelian gauge group of isotopic spin rotations. The vector corresponding vector fields, analogous to the photon field, were interpreted as describing spin one mesons. The obstacle was that these particles would have zero mass. It also seemed that the large coupling constant precludes the use of standard perturbation theory. New methods like the breaking of gauge symmetry, effects known as anomalies, and the renormalization group were needed to deal with these problems. Gauge theories were soon generalized to other gauge groups. Their quantization have been studied notably by Feynman, Faddeev and Popov, and De Witt, though the physical relevance became clear not before the late 1960s. Since then many physicists and mathematicians have contributed to Quantum Yang-Mills Theory and its thermodynamics. Starting 2005 Ralf Hofmann published important contributions together with F. Giacosa, M. Neubert, D. Kaviani, J. Ludescher, M. Schwarz, and M. Szopa. The present book provides a general introduction into calculation techniques used and an overview of the published results. What surprises me is that the path integral approach is avoided. The book has two main parts. Part 1 describes the theory, Part 2 the applications. The theoretical part aims to provide advanced students and researchers with the details of the nonperturbative, thermodynamically grounded, and largely analytical approach to four-dimensional flat space Quantum Gauge Theory. The second part treats the terrestrial, astrophysical, and cosmological applications within the realm of low-temperature photon physics.

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