$$L = -\frac{1}{2}\,\mathrm{Tr}\,\{\partial_\mu B_\nu - \partial_\nu B_\mu - g\,[B_\mu B_\nu]\}^2 - \frac{1}{\alpha}\,\mathrm{Tr}\,(\partial^\mu B_\mu)^2$$
$$+\,2\,\mathrm{Tr}\,\{\partial_\mu\phi^*\partial_\mu\phi - g\partial_\mu\phi^*\,[B_\mu,\,\phi]\} \tag{2.5}$$

where $\phi = \phi^a t_a$ is a massless, complex, scalar field which propagates in closed loops only and obeys Fermi statistics. The resulting Feynman rules are summarized in Figure 1.

Due to the presence of massless particles and the resulting infrared singularities it would appear that the S-Matrix does not exist, at least in perturbation theory, for the pure Yang-Mills theory. One can however consider the off shell Green's function for such theories, at all but exceptional momenta.[32] In the following, this restriction is always to be understood. The large momentum behaviour of such Greens functions is not without physical interest since it bears directly on the ultraviolet behaviour of more realistic models with symmetry breaking and mass terms.

Up till now we have discussed the Yang-Mills theory formally, that is without regard to the necessary renormalization procedure. There exist two ways of regularizing these theories. The most elegant method is that of dimensional regularization as discussed by t'Hooft and Veltman.[33] Alternatively, one can add gauge invariant higher derivative terms to the Lagrangian, following Lee, Zinn-Justin and Slavnov.[34,35] Both of these methods have the necessary virtue of maintaining explicit gauge invariance.

With such a regularization the only primitively divergent amplitudes are the vector-meson and ghost two and three point functions and the vector-meson four point function. The necessary