PHASES OF SUPERSYMMETRIC GAUGE THEORIES

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SUMMARY

During the last years remarkable progress was made in deriving exact results for the dynamics of supersymmetric gauge theories. In particular the knowledge of the low energy effective action characterizes unequivocally the phases which appear in these theories.

In the lectures presented at the School we reviewed the field trying to emphasize this aspect, i.e. the variety and characterstics of the phases gauge theories can be in. Though some of the features appearing are undoubtedly a consequence of the high supersymmetry these models posess, we believe that the lessons learned could be relevant for QCD.

All the interesting phases can be realized in the $N = 2$ supersymmetric gauge theories with gauge group $SU(2)$ studied by Seiberg and Witten. We list the non-perturbative information about these systems.

- In the $N = 2$ $SU(2)$ gauge theory without matter[1] the effective action has two singularities corresponding to points where magnetic monopoles and dyons become massless, respectively. When a small perturbation breaking the $N = 2$ supersymmetry to $N = 1$ is added the massless particles condense. The two phases obtained this way give a first exact realization in the continuum of the confining phase proposed by 't Hooft and Mandelstam and of the oblique confinement phase proposed by 't Hooft.

- Considering $N = 2$ $SU(2)$ gauge theory with e.g. three hypermultiplets in the fundamental representation[2] there are points where monopoles carrying nontrivial representation of the global symmetry group become massless. When such monopoles condense the global symmetry is spontaneously broken. This mechanism could be relevant for the general problem of breaking chiral symmetries in gauge theories.

- Particularly interesting and novel are the Argyres-Douglas[3] points where mutually nonlocal objects (i.e. objects which cannot be simultaneously described in the same "picture" of the electromagnetic field) condense. These points can be

realized in the framework of $SU(2)$ theories[4] by finetuning the mass parameters of the hypermultiplets in such a way that two singularities collide. Such a point necessarilly produces a superconformal theory and some information about the anomalous dimensions of the primary fields can be extracted.

The lectures followed closely the original articles[1, 2, 3, 4] and used extensively the excellent reviews available[5, 6, 7, 8].

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