

ASYMPTOTIC FREEDOM

&

INFRARED SLAVERY

M.Sc. (Physics) 4th Semester

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The force between quarks becomes weak at very short distances. At such distances quarks behave as independent particles and no strong force exist between them. Such kind of behavior (diminution of forces) shown by quarks is known as **Asymptotic Freedom**. However, quarks bind together because of that other fundamental characteristics of Quantum Chromodynamics (QCD), the increase of color charge at large distances.

In the language of wave mechanics, one always uses the term “infrared” for “long distances” and for this reason the phenomenon of strengthening of color charge at large distances is called **Infrared Slavery**. In a way, quarks are slaves of their own color charge. If we wish, we can think of them as bound like prisoners on a chain gang. If prisoners stay within few meters of each other, nothing much happens. They can move more or less freely i.e. they are free within limits. The problem begins only when one prisoner tries to get more than few meters away from others. If that happens, all prisoners are again reminded that they are in chains.

Replacing quarks with prisoners and the chains by chromoelectric strings, we arrive at an analogy (with QED) that accurately describes the dynamics of quarks and gluons inside a hadron.

So we assume that there is no isolated quarks, that they exist solely in color singlet configurations like mesons and baryons. Theory and experiments suggest that colors (quarks) are confined and quarks and gluons can appear only in form of hadrons. This is **confinement of Quarks**.

Bibliography:

“Quarks” by Fritzsche H.