dominated by the unitary Hagedorn states is altered to be dominated by the orthogonal Hagedorn states when the dilute nuclear matter is heated up to higher temperatures. Since the mass spectral exponent for orthogonal Hagedorns (i.e. colorless orthogonal states) is found to be $\alpha_1 = 3$, it is likely that the orthogonal Hagedorn matter undergoes third order phase transition to quark-gluon plasma. Furthermore, it is possible that the orthogonal Hagedorn states are altered to colorless $U(1)^{N_c}$ states when the very dilute nuclear matter is further heated up to higher temperatures. The very dilute nuclear matter might be created in the *pp* collisions at LHC besides the heavy ion collisions. The Hagedorn matter which is dominated by the colorless $U(1)^{N_c}$ has the mass spectral exponent $\alpha = 3/2$. Hence, the nuclear matter that is dominated by these states does not undergo direct abrupt phase transition to quark-gluon plasma but rather smooth cross-over phase transition. When the medium is further heated up to higher temperature these states (i.e. Hagedorn states with the mass spectral exponent $\alpha = 3/2$) may be mutated to metastable colored quark-gluon bags with the mass spectral exponent $\alpha = 1/2$. Since the states with mass spectral exponent $\alpha = 1/2$ do not pass direct explosive deconfinement phase transition to quark-gluon plasma, the colored quark-gluon bags expand smoothly and the system undergoes smooth phase transition to colored quark-gluon plasma.

The orthogonal Hagedorn states are mutated to the colorless $U(1)^{N_c}$ quark-gluon bags due to the high thermal excitations in the hot and very dilute nuclear matter (i.e. $\mu_B \approx 0$). Since the new nuclear matter turns to be dominated by the colorless $U(1)^{N_c}$ quark-gluon bags, it does not likely undergo direct phase transition to explosive quark-gluon plasma. But instead, the resultant Hagedorn states are gradually altered to metastable colored quark-gluon bubbles. The metastable colored quark-gluon bags expand gradually and overlap each other smoothly until the entire space is filled by giant colored (non-singlet) bags. The resultant matter have an initial neutral color charge aftermath the phase transition. Therefore, the constraints of the conserved color charges must be embedded in the system through the color chemical potentials. This kind of (color-non-singlet) matter with the mass spectral exponent α_{non} undergoes a smooth cross-over phase transition to non-explosive quark-gluon plasma. The multi-processes mechanism in the phase transition from the low-lying hadronic phase to the quark-gluon plasma strongly indicates the fluid behaviour for the quark-gluon plasma. The color-singlet states for the quark-gluon bag with an orthogonal color representation rather than the unitary one can be interpreted as a gas of Coulomb