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All the matter around us consists of atoms and molecules, whereas they consists of electrons and nucleons, i.e. protons and neutrons. We know that these nucleons have a structure too, and they consist of so-called quarks and gluons. These quarks and gluons have a peculiar feature that no-one has ever observed a single, free quark or gluon, but they always appear in groups confined to form protons, neutrons or other particles. However, this leads to a question what might happen if we have a large number of protons and neutrons compressed so close to each other that a distance between quarks in neighbouring protons and neutrons is the same than the distance between quarks within a proton or neutron. How would a quark know which quarks and gluons belong to the same proton or neutron than it does?

The theory describing how these quarks and gluons interact, so-called quantum chromodynamics or QCD, also implies that in sufficient temperature and density quarks and gluons would not form protons and neutrons, but would start behaving as individual free particles instead. They would form a new state of matter called quark-gluon plasma. The temperatures and densities required are immense, and the only way to produce such matter on Earth, are collisions of heavy nuclei at very high energies. On the other hand, in the very early universe immediately after the Big Bang, the temperature and density were large enough, and the young universe was filled by quark-gluon plasma.

We have reason to believe that in the heavy-ion collision experiments we have formed tiny droplets of quark-gluon plasma for fleeting moments of time. Now, the next step is to study what the properties of this matter are - the matter which filled the early universe during its first moments. There are indications that especially the specific shear viscosity of this plasma is extremely small, and thus it would be one of the most perfect fluids ever observed. But how small its viscosity exactly is, is still unclear. What complicates the measurement of the shear viscosity coefficient and other properties of quark-gluon plasma is that its lifetime in experiments is so short that we cannot observe it directly, but we have to deduce its existence and its properties from the conventional protons, neutrons and other particles flying out of the plasma.

In this project we aim to quantify the properties of this matter by using a fluid-dynamical model which connects the properties of the quark-gluon plasma to the distributions of the final, observed, particles. By careful analysis of what particles come out, what their momenta, i.e., velocities are, in which directions particles fly, how the amount of particles flying to a particular direction correlates with particles flying to another direction, and how all this varies from one collision to another, it is possible to deduce what the properties of the plasma, where the particles originated from, are.

In this way we aim to improve our understanding, not only about how the tiniest constituents of the matter around us behave, but also about the early universe and the origin of us all.