1. **Presenter Name & Institute:** Kemelzhanova Sandugash Esteuovna, al-Farabi Kazakh National University, Almaty, Kazakhstan
2. **Coauthors:**

Zazulin Denis Mikhailovich, al-Farabi Kazakh National University, Almaty, Kazakhstan; Institute of Nuclear Physics, Almaty, Kazakhstan

Ormantaev Orken, al-Farabi Kazakh National University, Almaty, Kazakhstan

Ezau Petr Davydovich, al-Farabi Kazakh National University, Almaty, Kazakhstan

1. **Abstract**

**Application of geometrothermodynamics to some systems with strong interactions described by the method of holographic dualities**

D.M. Zazulin1,2, Kim Sung Won3, O.S Ormantayev1, P.D. Ezau1, S.E. Kemelzhanova1

1al-Farabi Kazakh National University, Almaty, Kazakhstan;

2Institute of Nuclear Physics, Almaty, Kazakhstan

3Ewha Women University, Seoul, Korea

The geometric properties of the equilibrium manifolds of two thermodynamic systems with strong interactions predicted by the holographic dualities method [1,2] have been studied in this work. Geometrothermodynamics [3,4] was used as the formalism of the study, which allows to obtain results invariant with respect to the Legendre transformations, i.e. independent of the choice of thermodynamic potentials.

In this approach, we considered a new type of quantum liquid with a zero-sound mode at low temperatures in its spectrum and with an exotic temperature dependence of the specific heat [1]. For this liquid, entropy was taken as the thermodynamic potential, depending on the temperature and the baryon density.

Also the thermodynamic systems with a finite baryon density at zero temperature [2] have been considered. For these systems the thermodynamic potentials 𝛀 and Helmholtz free energy F that depend on the chemical potential μ and particle mass m were taken as thermodynamic potentials.

For the systems under consideration, the results of numerical calculations of the corresponding metrics, the metric tensors determinants and scalar curvatures are presented in the form of 3-dimensional graphs. The graphs presented clearly show at what values ​​of thermodynamic variables the scalar curvatures tend to infinity or to zero, which indicates possible phase transitions and possible compensation of interactions by quantum effects, respectively.

The second-order phase transition, defined in [2] at m = μ, have been reproduced by us in the geometrothermodynamic approach.

**References**

1. A. Karch, D.T. Son, and A.O. Starinets (2009) Zero sound from holography, Phys. Rev. Lett. 102, 051602, DOI: 10.1103/PhysRevLett.102.051602.
2. A. Karch, A. O'Bannon (2007) Holographic thermodynamics at finite baryon density: some exact results, JHEP 0711:074, DOI: 10.1088/1126-6708/2007/11/074.
3. H. Quevedo (2007) Geometrothermodynamics, J. Math. Phys. 48, 013506, DOI: https://doi.org/10.1063/1.2409524.
4. H. Quevedo, A. Sanchez, S. Taj, A. Vazquez, (2011) Phase transitions in Geometrothermodynamics, Gen. Rel. Grav. 43: 1153. [arXiv](https://en.wikipedia.org/wiki/ArXiv):[1010.5599](https://arxiv.org/abs/1010.5599)