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CRC-TR 211
Strong-interaction matter under extreme conditions

Diffusion of conserved charges in relativistic heavy ion collisions

Preprint: arXiv:1711.08680

Moritz Greif

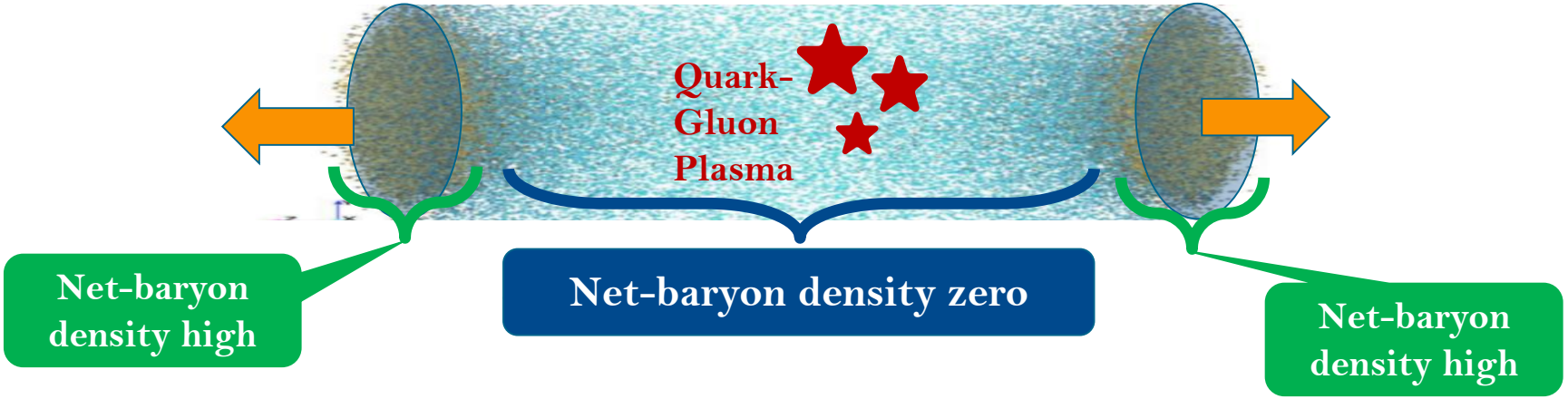
in collaboration with

Jan Fotakis, Gabriel Denicol, Carsten Greiner

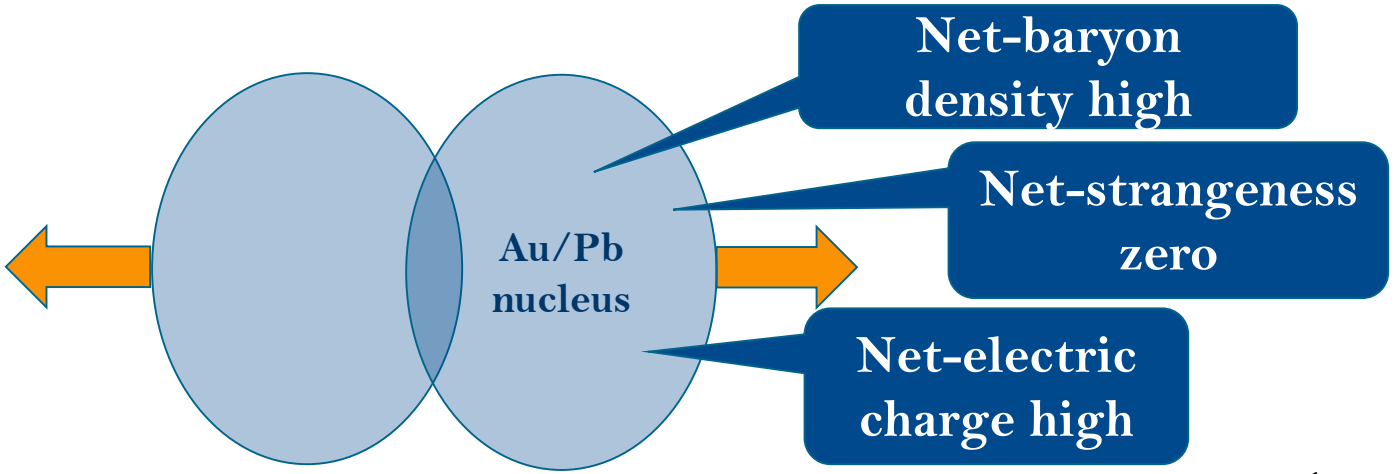
Bormiomeeting 2018

Heavy-ion collisions

- **High energy collisions: Net-charges zero (y=0):**



- **Low energy collisions: Net-charges remain**



Diffusion in relativistic kinetic theory

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$$\begin{pmatrix} j_B^\mu \\ j_Q^\mu \\ j_S^\mu \end{pmatrix} = \begin{pmatrix} \kappa_{BB} & \kappa_{BQ} & \kappa_{BS} \\ \kappa_{QB} & \kappa_{QQ} & \kappa_{QS} \\ \kappa_{SB} & \kappa_{SQ} & \kappa_{SS} \end{pmatrix} \cdot \begin{pmatrix} \nabla^\mu \alpha_B \\ \nabla^\mu \alpha_Q \\ \nabla^\mu \alpha_S \end{pmatrix}$$

Charge Currents

Gradients of given charge generate dissipative currents of other charge

Charge Gradients

Results

$$\begin{pmatrix} j_B^\mu \\ j_Q^\mu \\ j_S^\mu \end{pmatrix} = \begin{pmatrix} \kappa_{BB} & \kappa_{BQ} & \kappa_{BS} \\ \kappa_{QB} & \kappa_{QQ} & \kappa_{QS} \\ \kappa_{SB} & \kappa_{SQ} & \kappa_{SS} \end{pmatrix} \cdot \begin{pmatrix} \nabla^\mu \alpha_B \\ \nabla^\mu \alpha_Q \\ \nabla^\mu \alpha_S \end{pmatrix}$$

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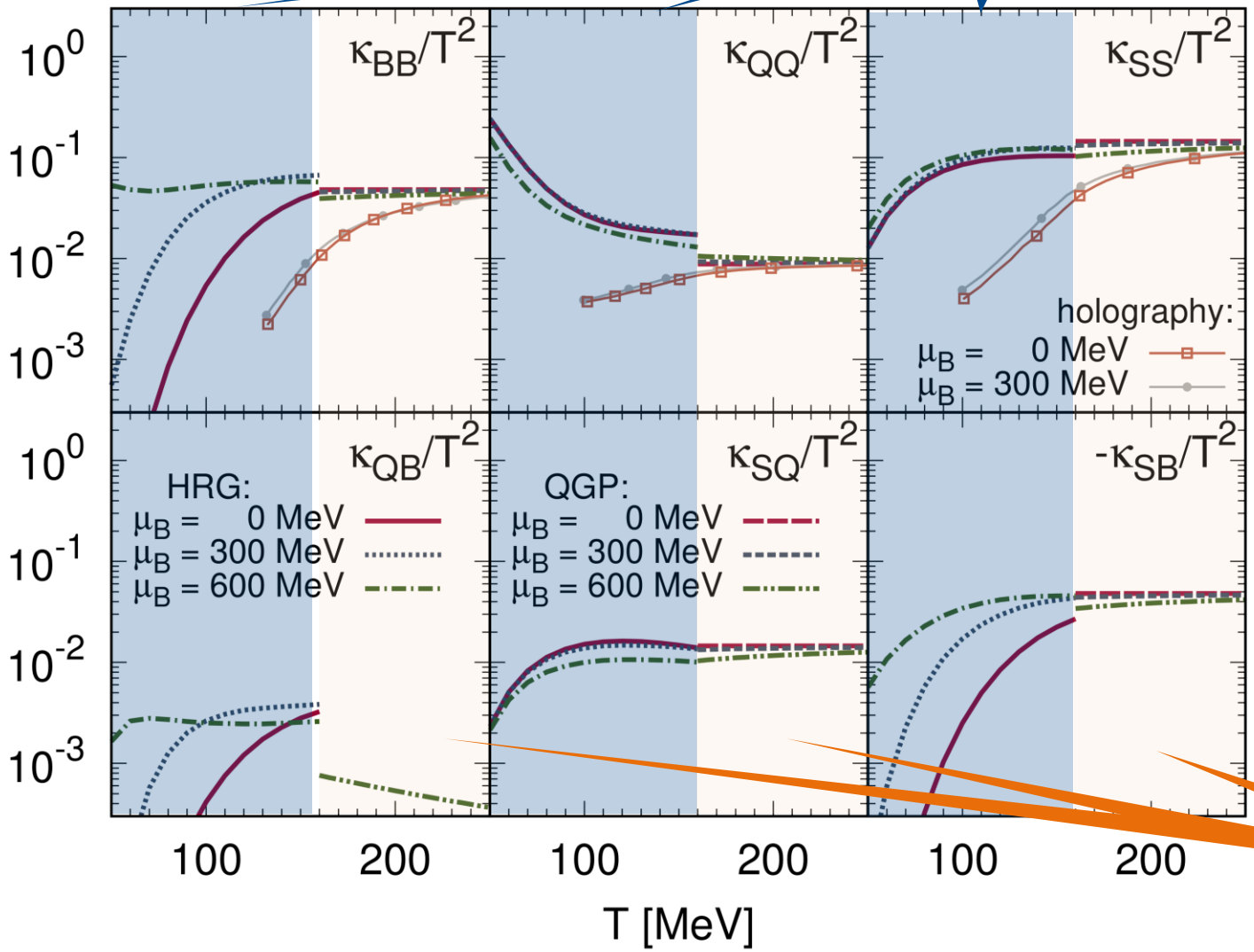
Hadron Resonance Gas



QGP

Conclusions & Outlook

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What ?

- First calculation of complete diffusion matrix of B,Q & S charges
- Realistic Hadron gas and simple conformal QGP model
- Well tested „Chapman-Enskog“ calculation, based on Boltzmann Eq.

Results:

- Strong coupling of all gradients to all currents
- Suggestion: Off-diagonal terms must not be ignored
- Precise T & μ-dependent values for the coefficients to be immediately used in (hydro) models

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Future possibilities:

- Diffusive 3-charge hydro model
- Which diffusion effects really important in experiments?
- Compare to lattice-QCD? FRG? ChPT? DQPM?