TT21 Morning of Theoretical Physics Q&A

Question	Answer(s)
Interesting point about astrophysical hydrodynamics... the Couomb mean free path in nebulae is often >> system size, so hydrodynamic approximation should not work. Particles are confined by plasma (not hydrodynamic) turbulence? The microphysics matters.	live answered
Thinking about microscopic to thermodynamics shift of viewpoint (multiple particles to few quantities), is there any relation to epidemiological modelling techniques?	live answered
Thanks, Steve - great talk! You pointed out that the flow of 'star fluid' in the galaxy gets less hydrodynamic as you move out from the centre; is there some way to do 'first corrections' to hydrodynamics to describe the flow as the approximation of local equilibrium gets worse?	live answered
I'm not sure why equilibration is necessary when definitions of density, local mean velocity, pressure are independent of it.	live answered
For quantum fluids which have supersition and other spooky quantum effects, how can you apply a classical Navier Stokes ?	live answered & more: In quantum systems, Navier-Stokes equations are written for expectation values, which are classical functions.
Would stars in a globular cluster be in hydrodynamic equilibrium?	live answered
Is there research taking place into hydrodynamics of gravitational waves?	live answered
You mentioned earlier about quark-gluon plamsa. Does it equilibrate in the similar way as electron plasma? If not, how is the equilibration process of different types of plasma different from each other?	I should defer to someone who has studied quark-gluon plasma a bit more. But... basically the general principle should be sound: that if you have enough interaction between the constituent particles, this allows equilibration. Fundamentally - yes. But quark-gluon plasma is a strongly interacting quantum fluid, kinetic theory does not apply, and one has to use non-perturbative tools to study equilibration mechanisms. I will mention this a bit in my talk later.
Very nice talk Steve!	Thank you!
Is superconductivity hydrodynamic electron flow? If not, why not?	Very good question. For superconductors and superfluids there are some modifications of hydrodynamics that you have to worry about. For example, the viscosity of the superflow is exactly zero. Another strange property is that (due to quantum effects) circulation of the superfluid is quantized in integer units of hbar/mass. However, other properties of hydrodynamics do still remain.

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Thank you for your answer. My interpretation of what you were saying is that out of equilibrium these quantities (density, local mean velocity, pressure) are no longer the only variables in the system of equations and these 'other quantities' we must keep track of enter into an appropriate extention of Navier-Stokes?	Yes, that is correct. I will mention this in my talk later. There are corrections to Navier-Stokes still within hydro regime. In ADDITION to that, at some point non-hydro degrees of freedom enter - hydro has its limitations.
Thank you for an excellent talk. You said that we could ignore the L^N conserved quantities in a generic L-site N-particle quantum system because most of them don't have associated local densities. That sounds as if it's specific to the real-space basis; is that the case (in which case why is real space special?), or is it that these conserved quantities don't have local densities in any single-particle basis?	live answered
Do we usually study quantum integrable systems with the Hubbard model? You seem to have put in t and U in the figure you used on the slide, which remind me of the Hubbard model.	live answered
Does the tracer approach work where time itself is quantised? cf Quantum loop gravity models.	
Does the emergence of hydrodynamics from QM tell us anything about the emergence of standard classical mechanics from QM	live answered
Are the particles which form the two clouds of particles in the QM Newton cradle distinguishable or indistinguishable (e.g. different hyperfine states)?	sorry Jonathan, missed this one, Julia. Sorry, I also missed it! They are in the same hyperfine state.
thanks!	
Can you recommend a book primer for this?	live answered & more: “Gauge/String Duality, Hot QCD and Heavy Ion Collisions” by Casalderrey-Solana, Hong Liu, David Mateos and K.Rajagopal
Isn't the 377 ohms what electrical antenna engineers called the impedance of free space? If so what does the black hole contribute	live answered
Does the black hole duality have any consequences to things we can observe about actual black holes?	live answered
1) What are the common non-perturbative approaches to tackle the strong coupling regime? Do researchers usually just apply the holographic tools to map to a weak coupling problem so that one simply applies pertubative approaches? 2) What do you mean exactly by spectrum of a black hole? The energy spectrum? Is it discrete like atomic spectra?	live answered

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Is there an intuitive picture for how a hydrodynamic description can work without local thermalisation? Is it just because the system is so strongly coupled that you can still get collective behaviour without thermalisation (sorry, I know collective behaviour is not the right word, but I cannot think of anything appropriate here)?	live answered
Could this work on black holes give us any hints on what settings/parameters to put into the particle accelerator/restricted degree of motion systems we heard about earlier?	live answered
Thanks - most interesting!	