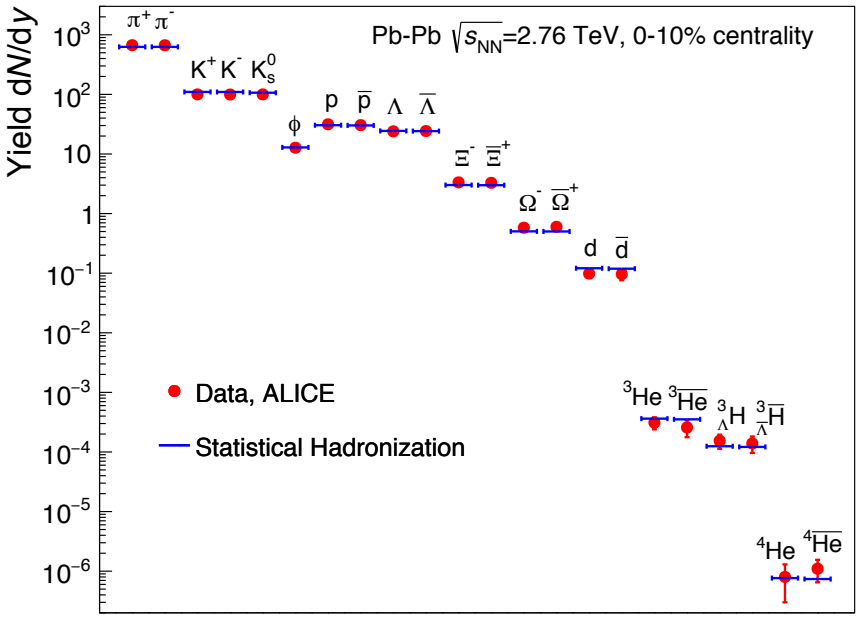
Origin of nuclear clusters 2020

Workshop summary / Kfir Blum (Weizmann Institute & CERN)

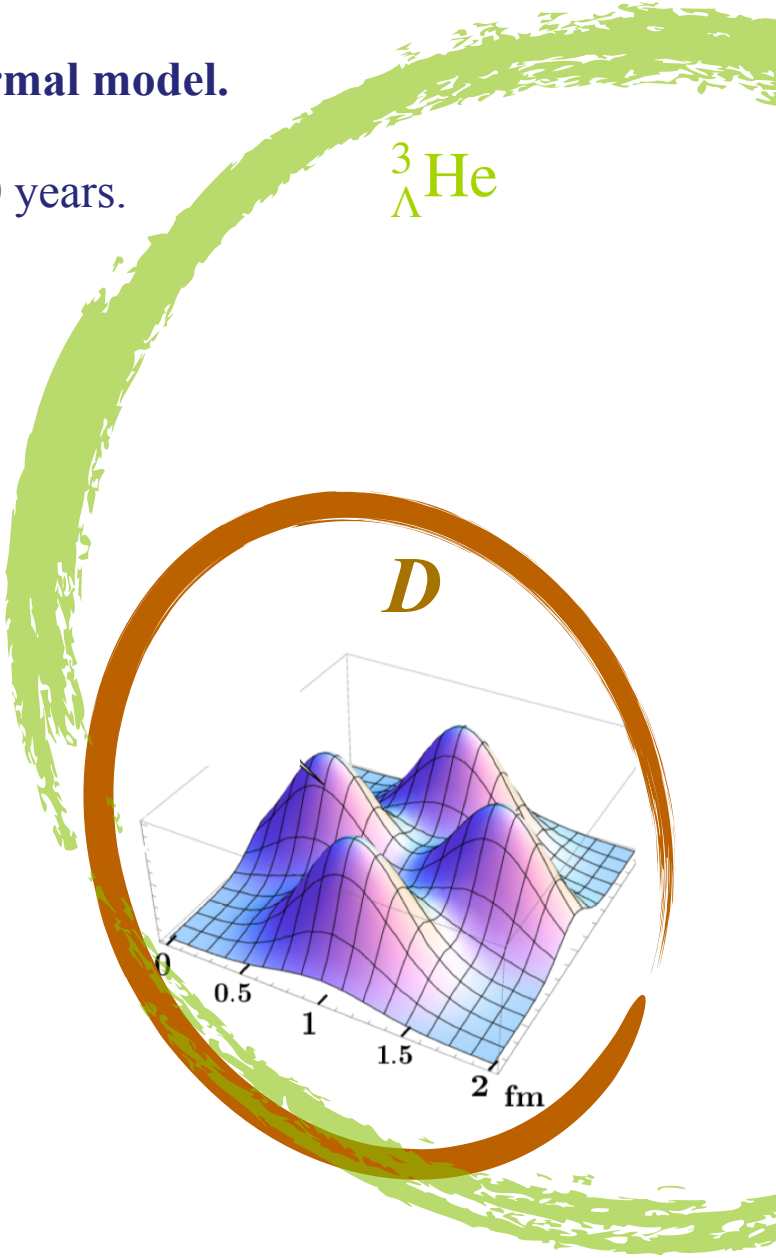
Verifying the thermal model for clusters would be *amazing* news for QCD cross-over dynamics.

— We did not hear of a theory for clusters in the thermal model.

It was not too early to consider such theory in the last 20 years.
But it may be too early now (with ALICE).



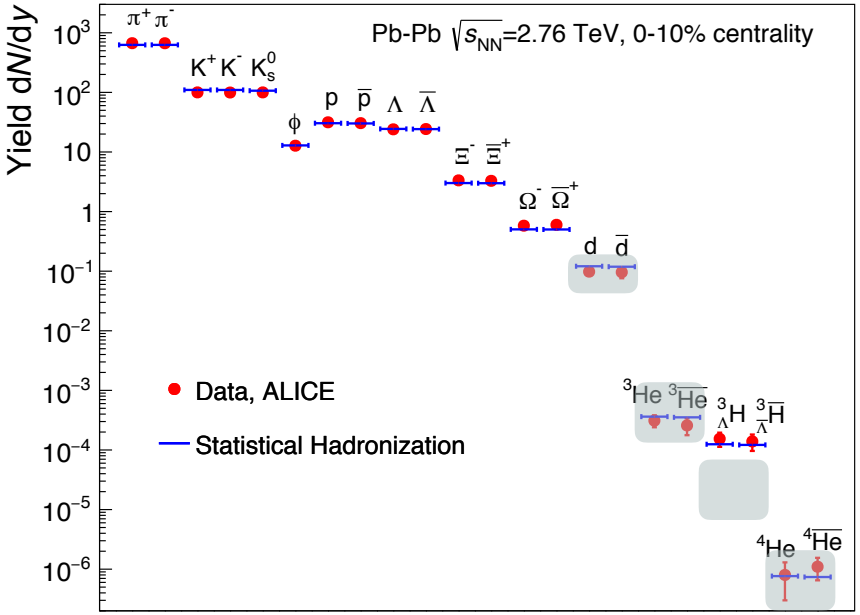
Andronic / May 19



Coalescence: clusters come from around the kinetic freeze out surface.
Reflection of the nucleon distribution function is emergent, not intrinsic.

$$E\frac{d^3N_A}{d^3P} = \frac{2J_A+1}{(2\pi)^3}\int_{\Sigma_f} P\cdot d^3\sigma(R)\, f_p^Z(R,P/A)\, f_n^N(R,P/A)\, C_A(R,P)$$

Heinz / May 19



— A theory, but no more than an effective theory of freeze out dynamics.

(— Mrowczynski: ``semi-classical source localised in space & momentum, emits off-shell nucleons";
…may be correct, but is a description in words of what we need, rather than a derivation of what we need)

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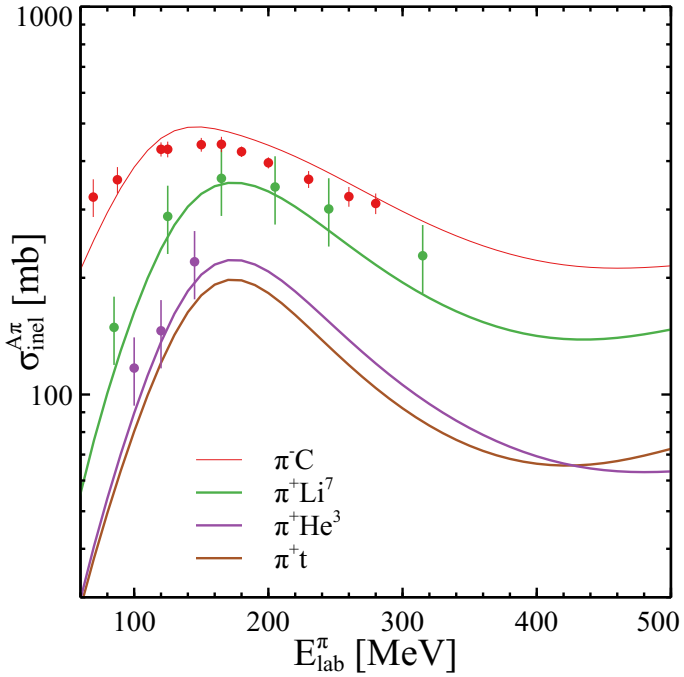
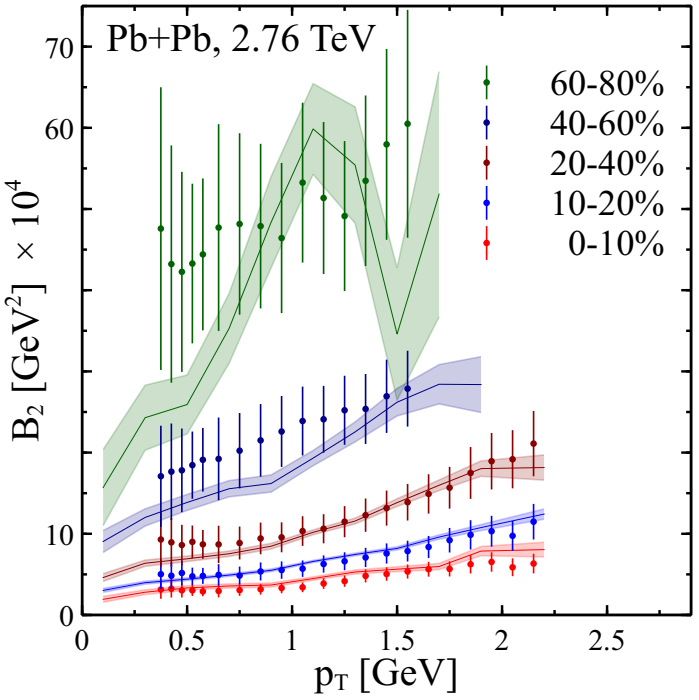
Oliinychenko, Vovchenko / May 19: welcome attempts towards kinetic theory.

$$\frac{dN_A}{d\tau} = \langle \sigma^{\text{in}}_{A\pi} v_{rel} \rangle \, n^{\text{pce}}_{\pi} \left(N^{\text{saha}}_A - N_A \right)$$



DO, Pang, Elfner, Koch, PRC99 (2019) no.4, 044907



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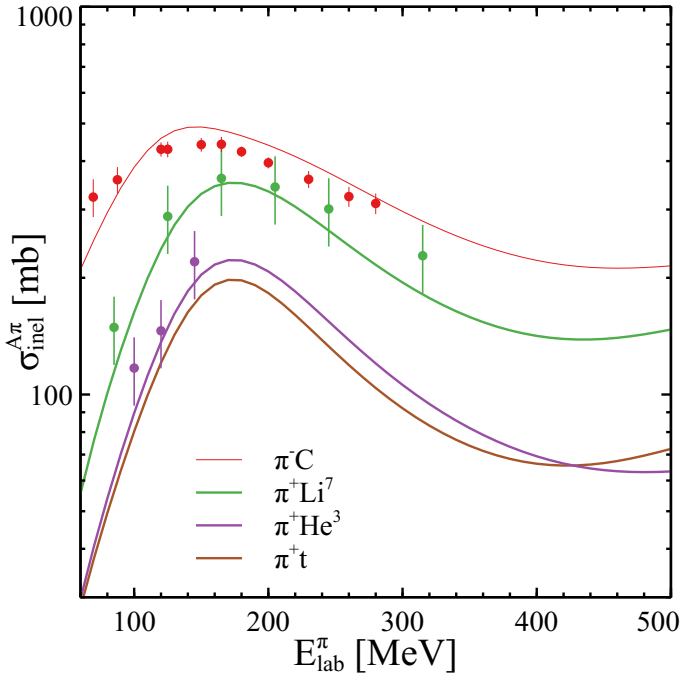
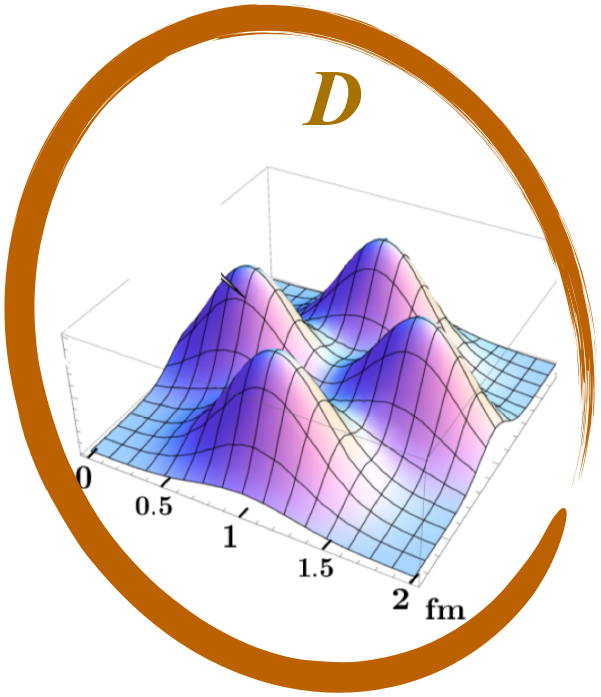


Wiedemann: should kinetic theory apply?



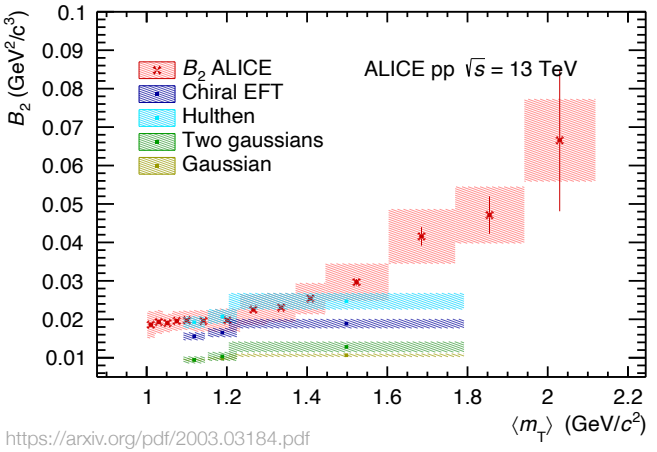
$$\ln Z_i = \frac{V g_i}{2\pi^2} \int_0^\infty \pm p^2 \mathrm{d}p \ln[1 \pm \exp(-(E_i - \mu_i)/T)]$$

vs.

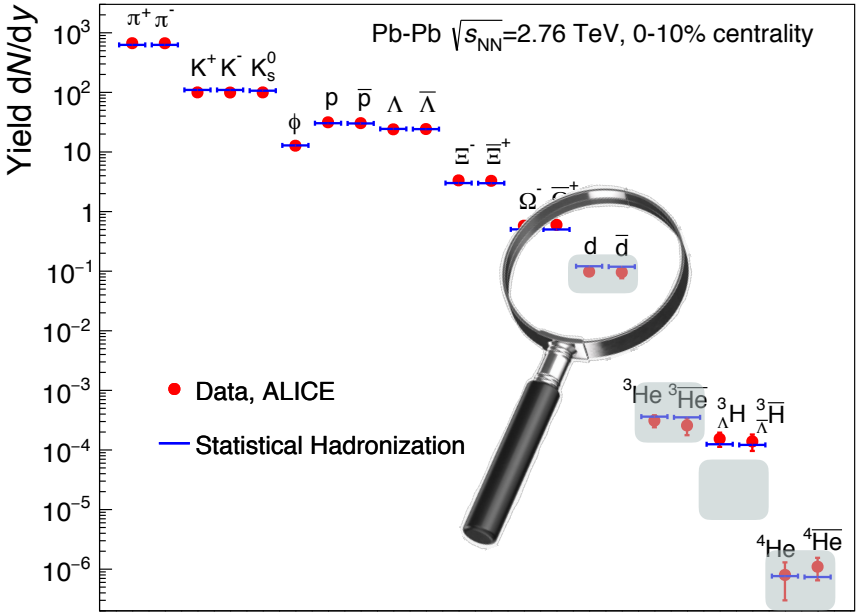
$$E\frac{d^3N_A}{d^3P} = \frac{2J_A+1}{(2\pi)^3} \int_{\Sigma_f} P \cdot d^3\sigma(R)\, f_p^Z(R, P/A)\, f_n^N(R, P/A)\, \mathcal{C}_A(R, P)$$

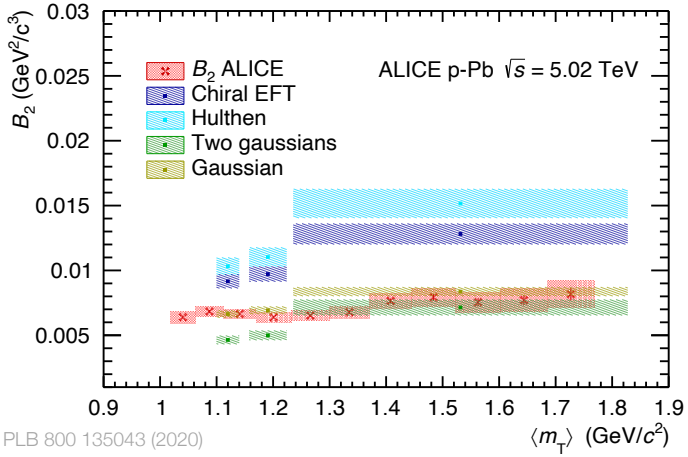
Experiment will answer.

Hohlweger / May 19



https://arxiv.org/pdf/2003.03184.pdf





PLB 800 135043 (2020)

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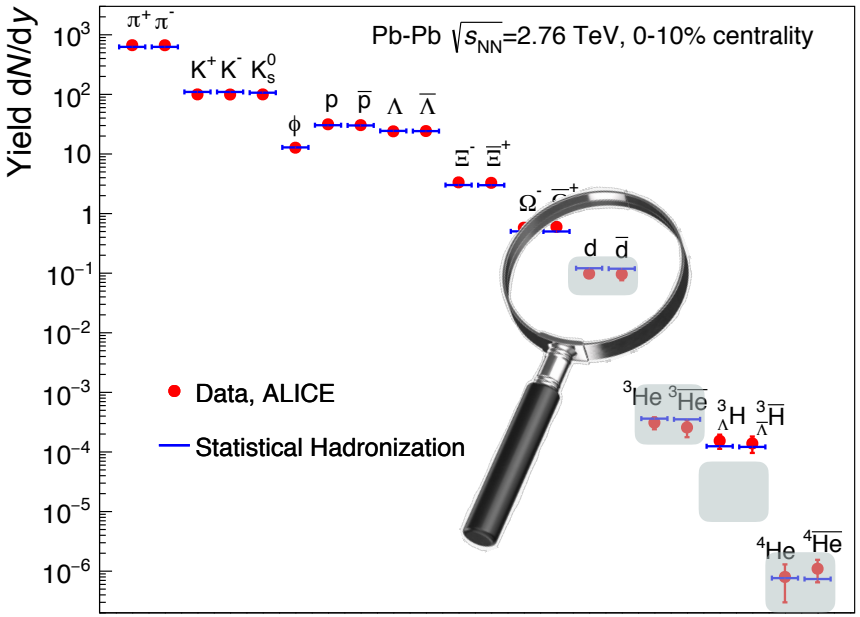

Hohlweger, **Barioglio** / May 19

Marrying HBT & cluster yields:

— We want spectra, clusters, HBT with same event class and kinematics selection!

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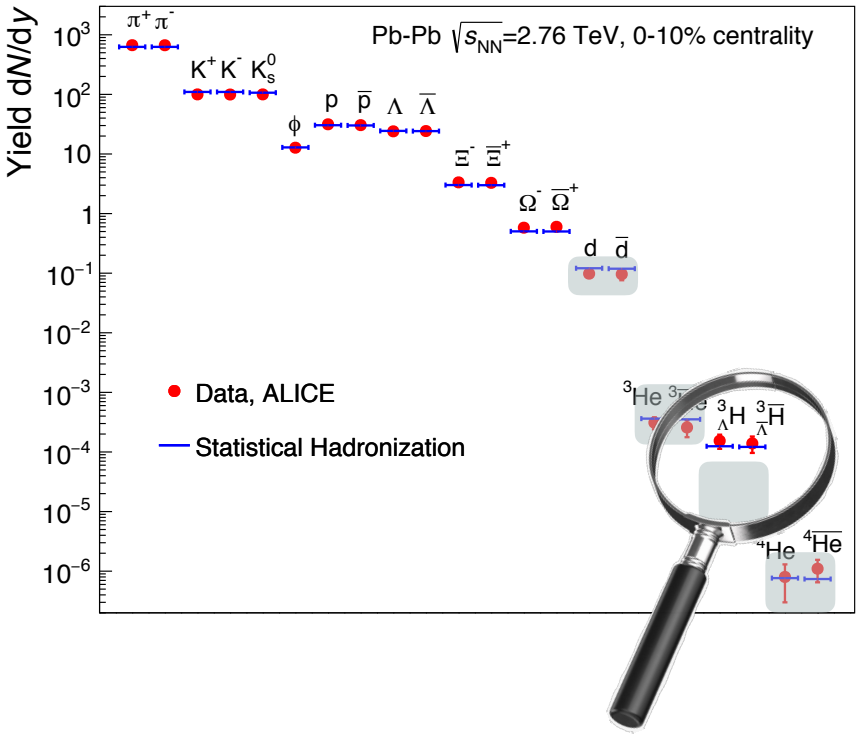
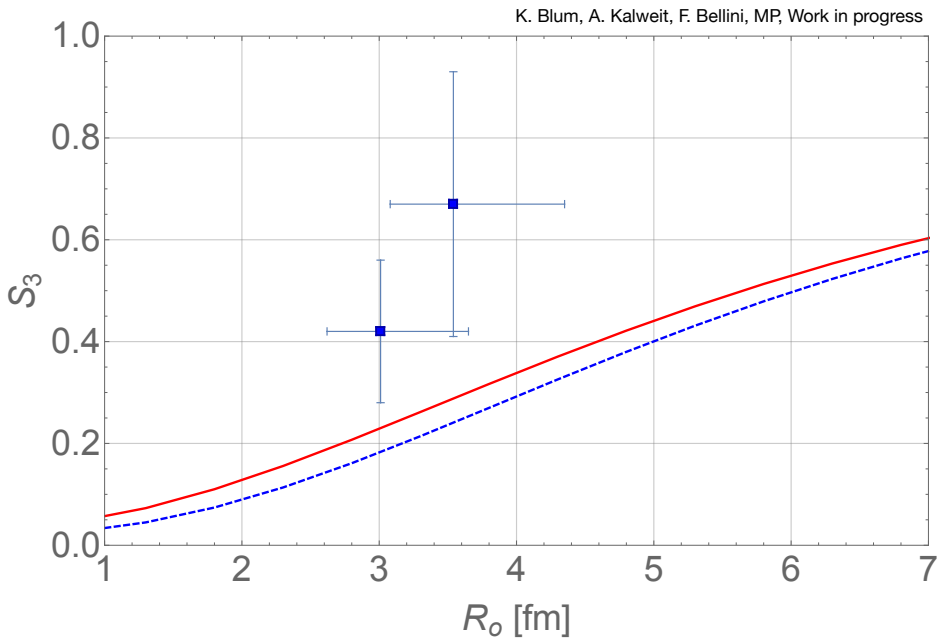
Experiment will answer.

Hammer; Richard; Puccio / May 20

Hyper T a key observable.





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Thermal model: what is the theory? — if true, amazing.

Coalescence: what is the microscopic picture?

Experiment: Marry spectra, cluster yields, HBT on same event class, kinematics.
Do not be afraid to exclude one or both of these simplistic models.
Highlight order of mag, or at least O(1), effects.

A number of key observables can answer very soon:
Hyper-T,
D, He3, He4 combining HBT w/ clusters,
eventually other nuclei and correlations (He4/Li4, pD? Mrowczynski / May 20)