# Triplet Correlations in Weakly Disordered Arrays of Flux Lines within Elemental Type II Superconductors

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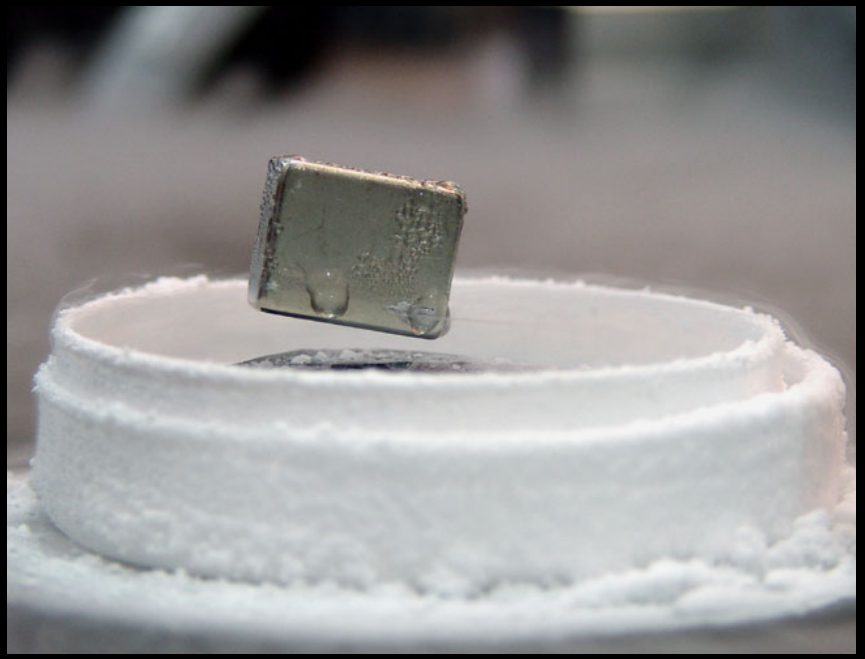
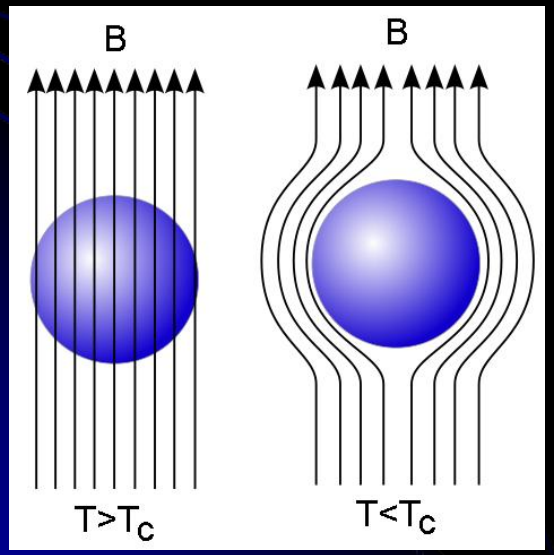
SURF 2008



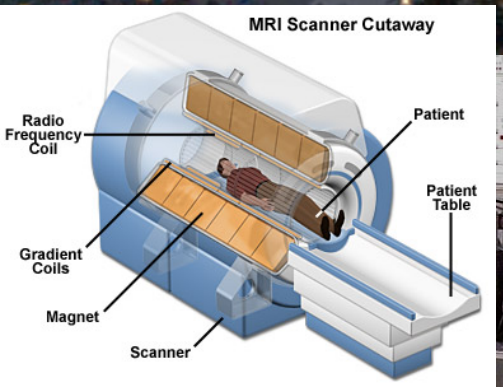
# Overview of Superconductivity

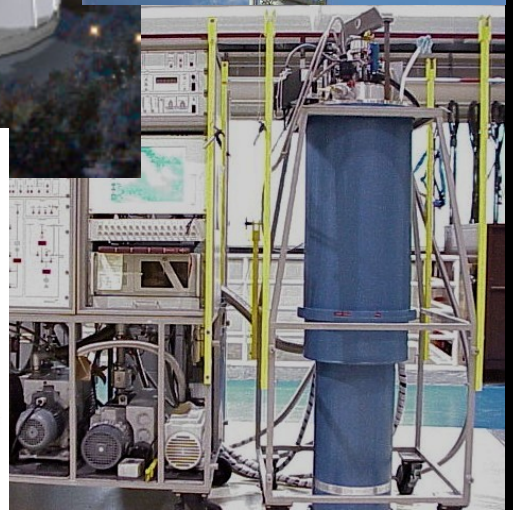
- Critical Temperature and Critical Field
- Electrical Resistivity
- Magnetic Fields
- Limits?





# Applications for Superconductivity



- Power Generation and Storage
- RF filters (e.g. Mobile Phone Towers)
- Ultrasensitive Magnetometers
- Strong Magnets (11.5T)

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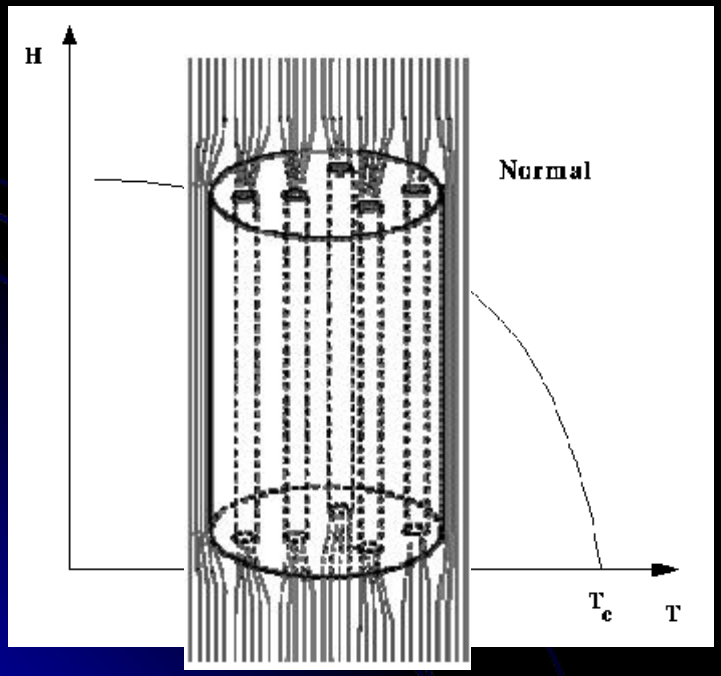
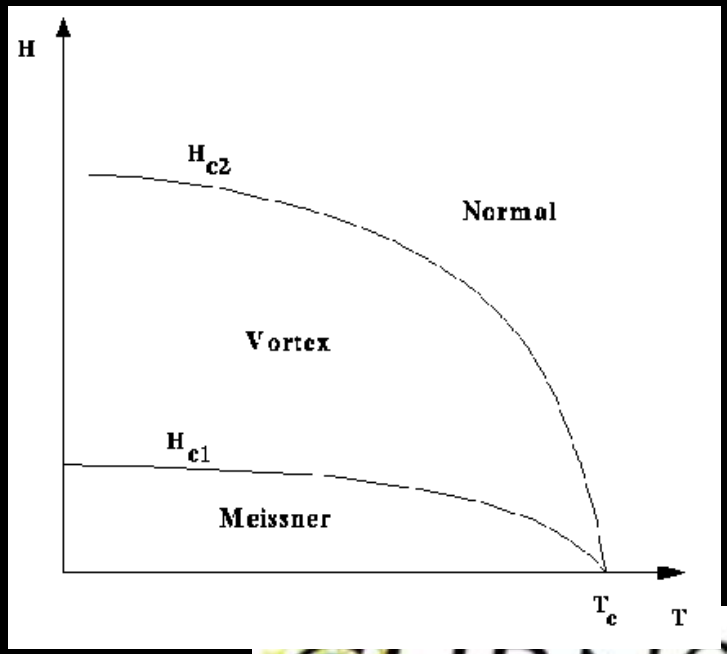
# Type I vs. Type II Superconductors

- L He vs. L $N_2$
- Meissner Ochsenfeld State vs. Mixed State
- Resistance in the Vortex State



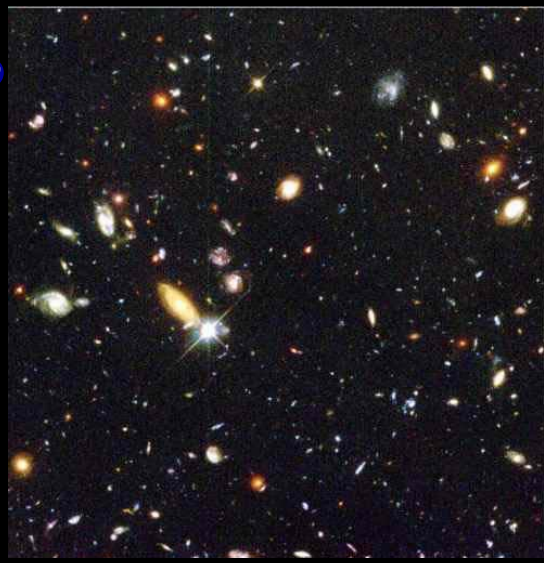

Type I

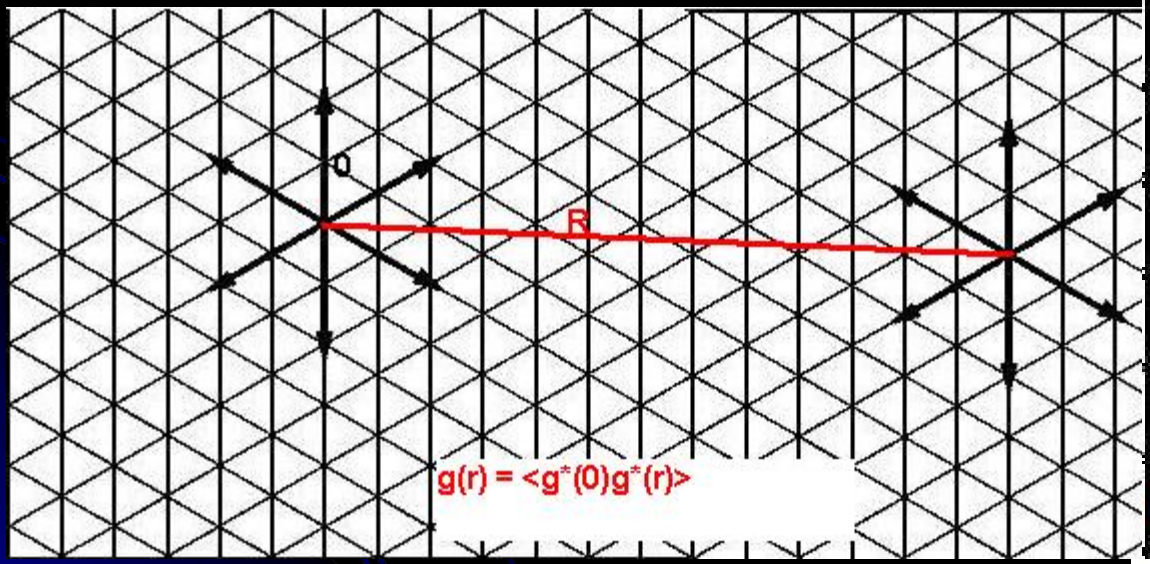


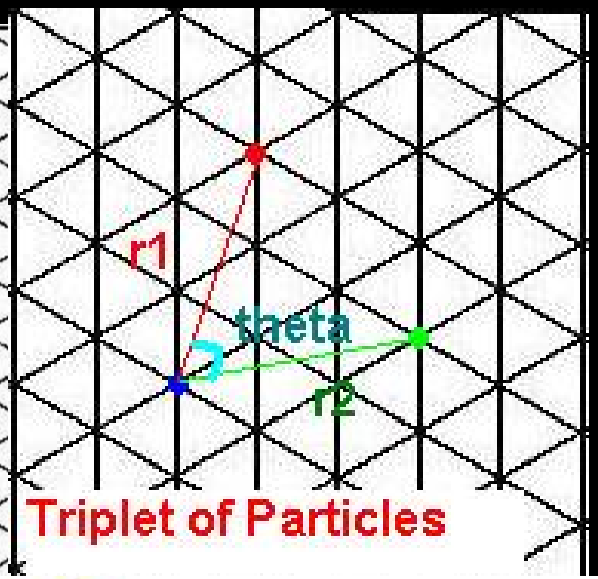

Type II

# Overview of Correlation Functions

- What is a Correlation Function?
- Pairs vs. Triplets
- How we use them now



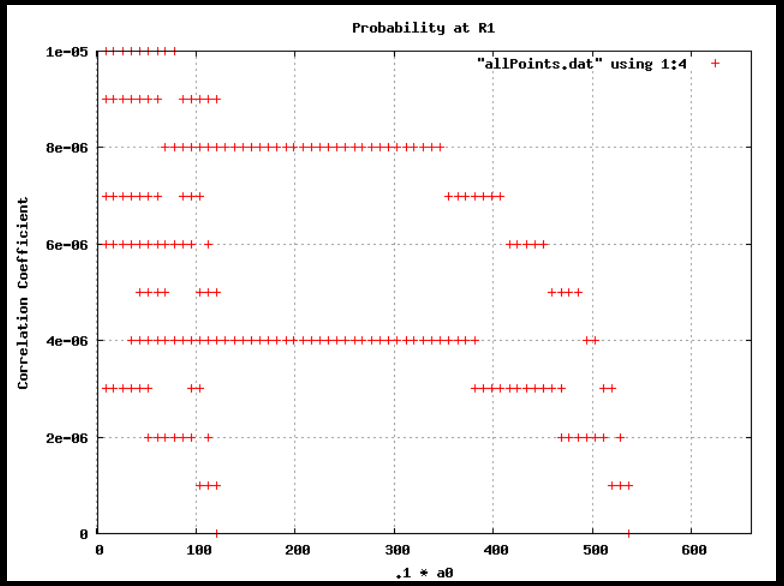


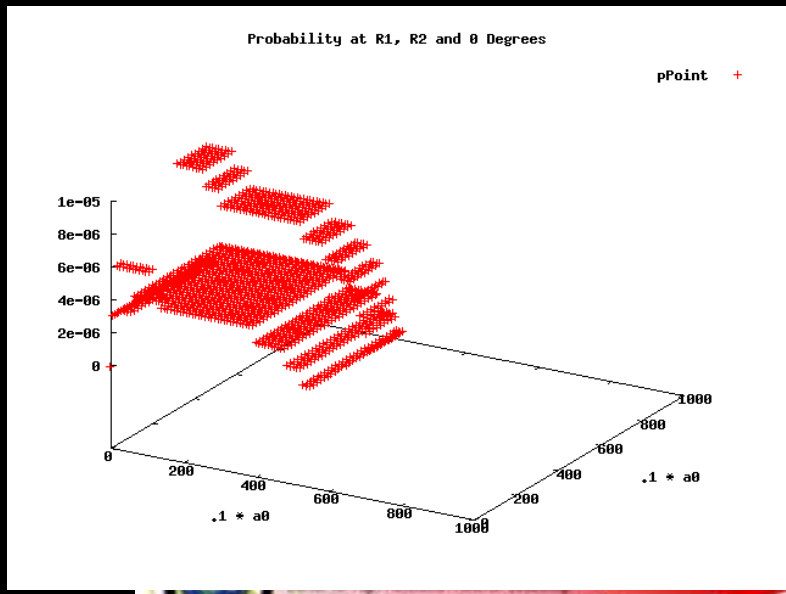




$$\varrho^3 (r_1, r_2, \theta) = \langle \varrho^*(r_{1i}, r_{2i}, \theta_i)\, \varrho^*(r_{1j}, r_{2j}, \theta_j) \rangle$$

# Triplet Correlation Function

- Potential to be more accurate in describing and predicting trends
- Much more complexity in both computing and interpretation
- Motivation: Muons



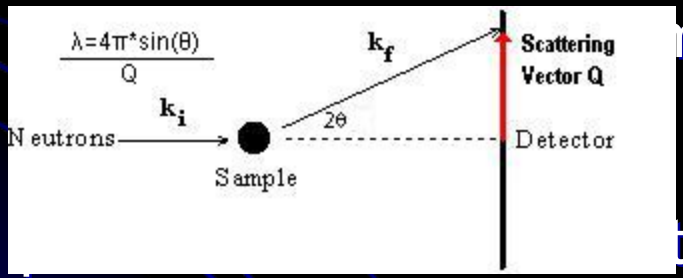



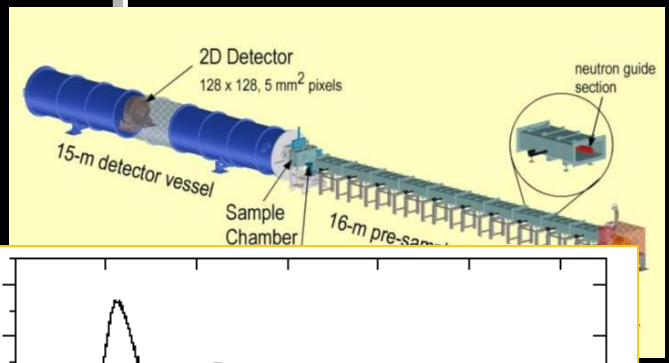

Top: Density$^2$ Function

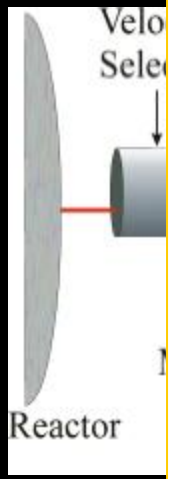
Bottom:Density$^3$ function (time resolved theta)

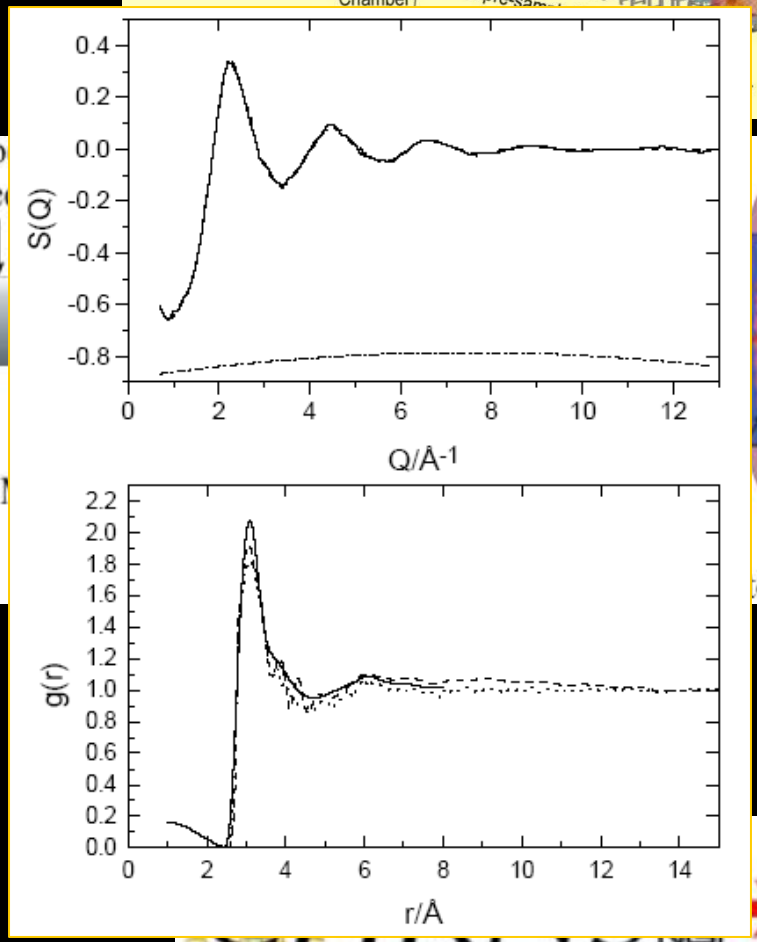
# Experiment Description

- A Small Niobium Crystal placed in a 200mT field and 2.6K in a Small Angle Neutron Scattering (SANS) machine
- Measurement with Neutrons
- n
- to determine locations of superconducting vortices



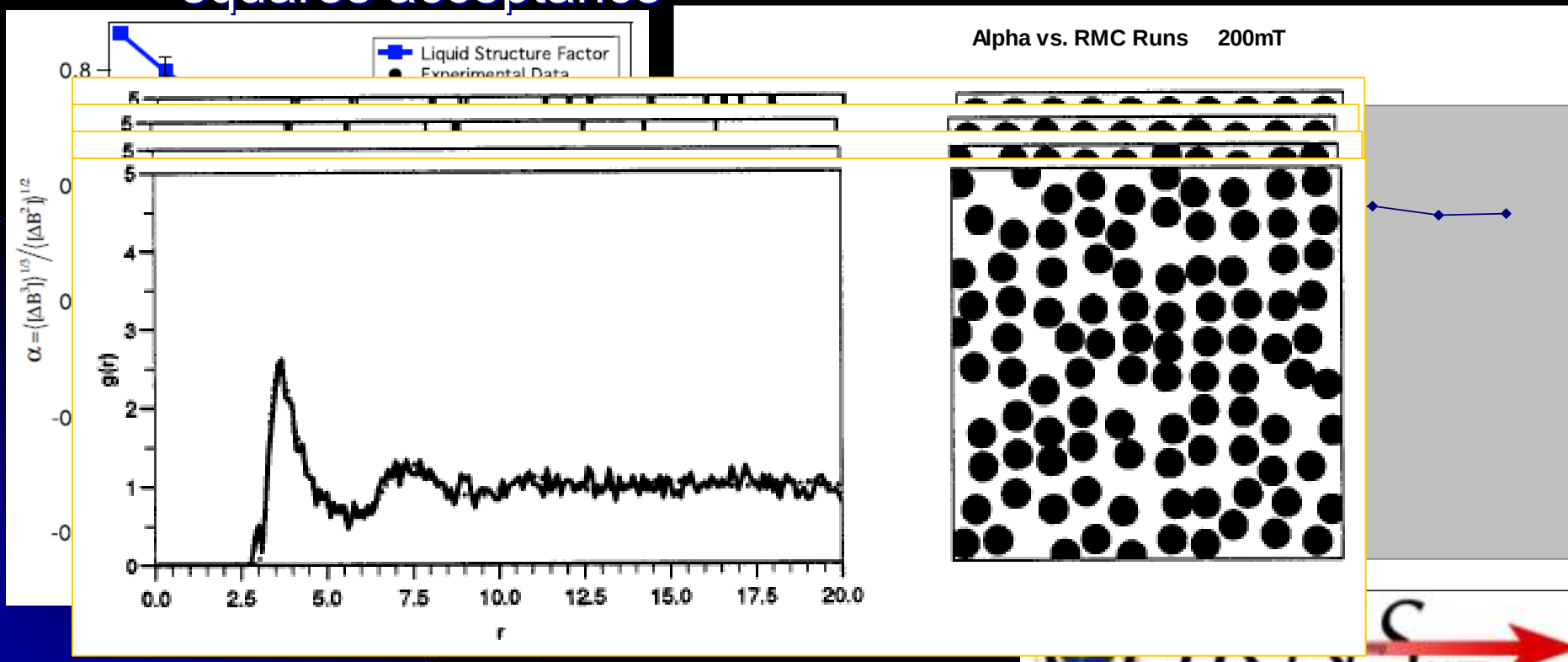



# RMC Analysis

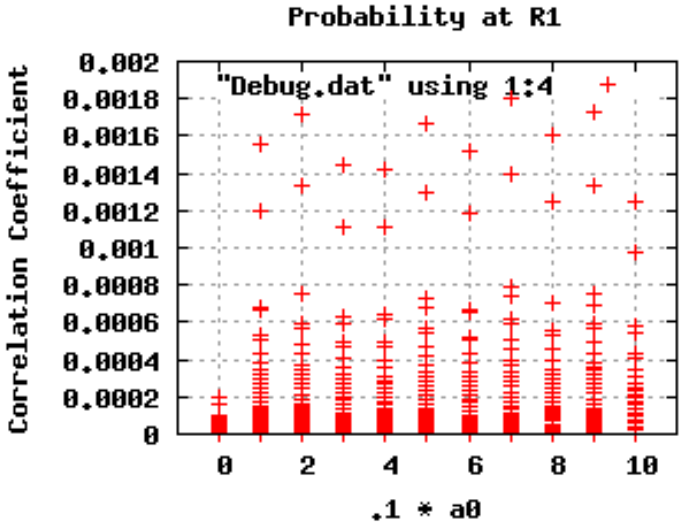
- Reverse Monte Carlo (RMC):
  - Enables representative calculation of correlation functions and observation of trends
  - Random Perturbations of the lattice with a least-squares acceptance

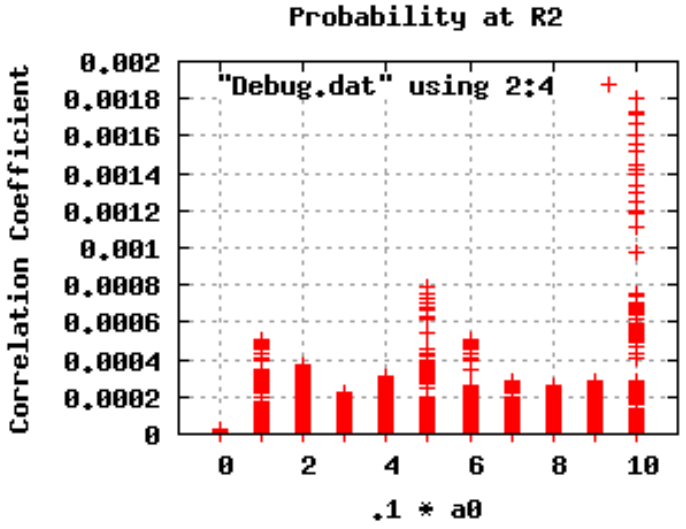


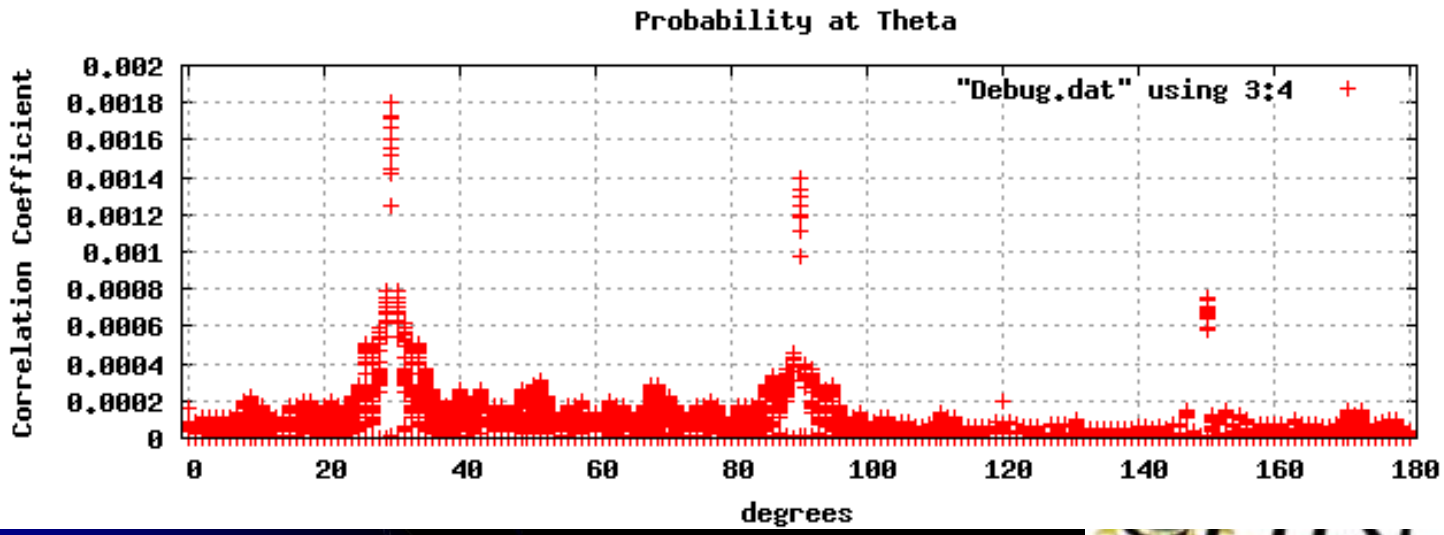
# Calculating Triplet Correlations

- Using Perfect Data:
  - A program was written to generate the perfect lattice and compute the density$^3$ correlation function.
  - Given the four dimensional nature of the data, time or color resolved graphs are preferred.

# Sample Data


Probability at R1
"Debug.dat" using 1:4
Correlation Coefficient
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
2
4
6
8
10
.1 * a0


Probability at R2
"Debug.dat" using 2:4
Correlation Coefficient
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
2
4
6
8
10
.1 * a0


Probability at Theta
"Debug.dat" using 3:4
Correlation Coefficient
0.002
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
20
40
60
80
100
120
140
160
180
degrees

# Questions?