DETERMINATION OF PREISACH DENSITY FUNCTION & EXAMPLES

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Xu Group Meeting

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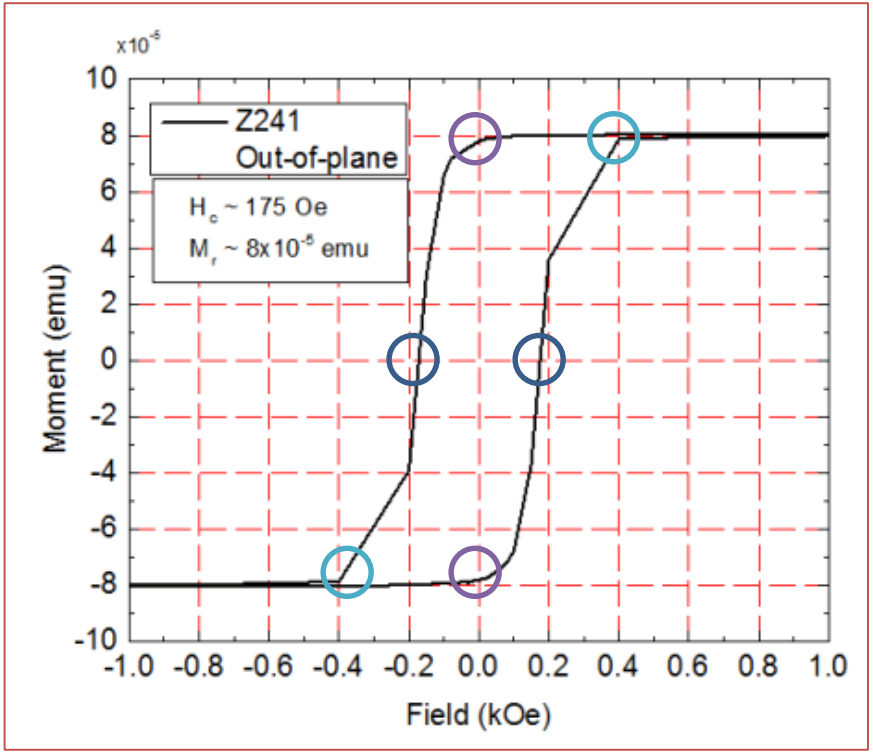
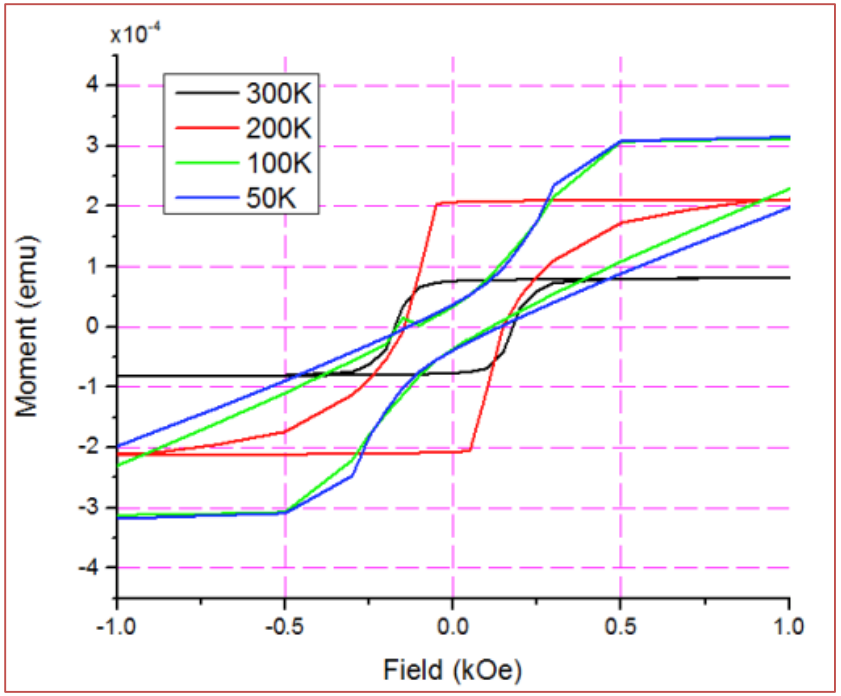
HYSTERESIS LOOPS

- Coercive field (H_c)
  - Field required to demagnetize
- Remnant magnetization (M_r)
  - Magnetization at zero field
- Saturation & saturation field
  - Moment at saturation, and field to reach saturation



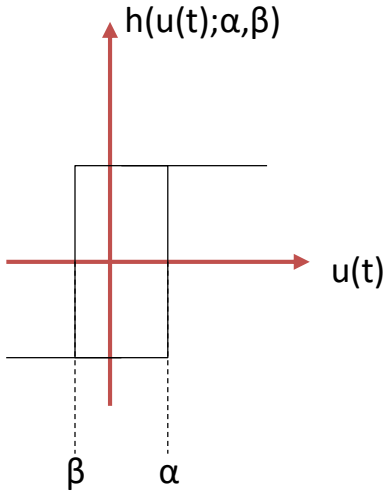
MORE COMPLEX HYSTERESIS LOOPS

- At low temperature shapes look less square
  - Different phases of magnetism in sample at low T?
- Want to break into individual hysteresis loops



PREISACH MODEL OF MAGNETISM

- Hysteron: basic function of Preisach model (break all hysteresis loops into a linear combination of basis $h(x;\alpha,\beta)$
  - 2d space of transformed coordinates
  - h is not single-valued

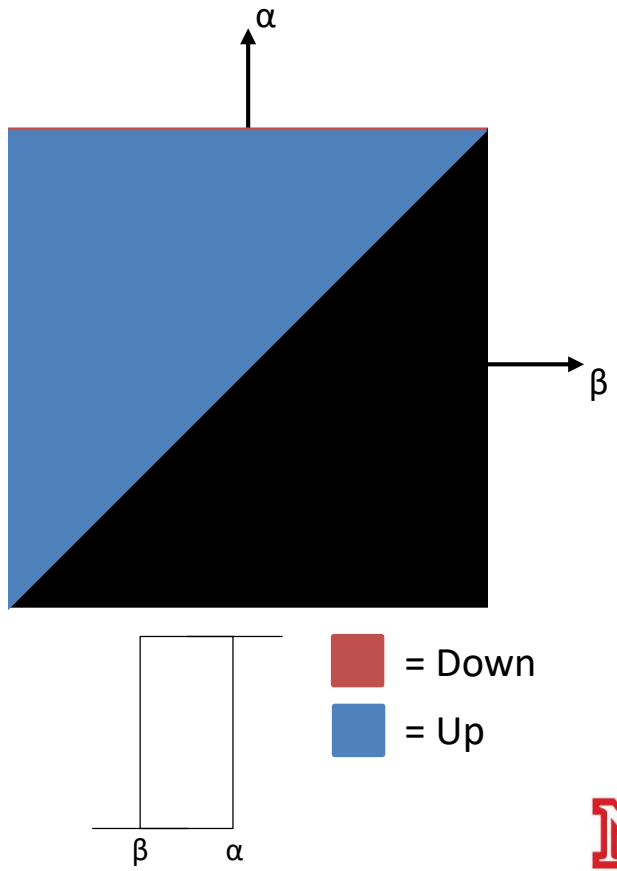


$$h(u(t);\alpha,\beta) \equiv \begin{cases} -1, u(t) \le \beta \\ 1, u(t) \ge \alpha \\ k, \beta < u(t) < \alpha \end{cases}$$

where k=±1, depending on which direction you approach (α,β)

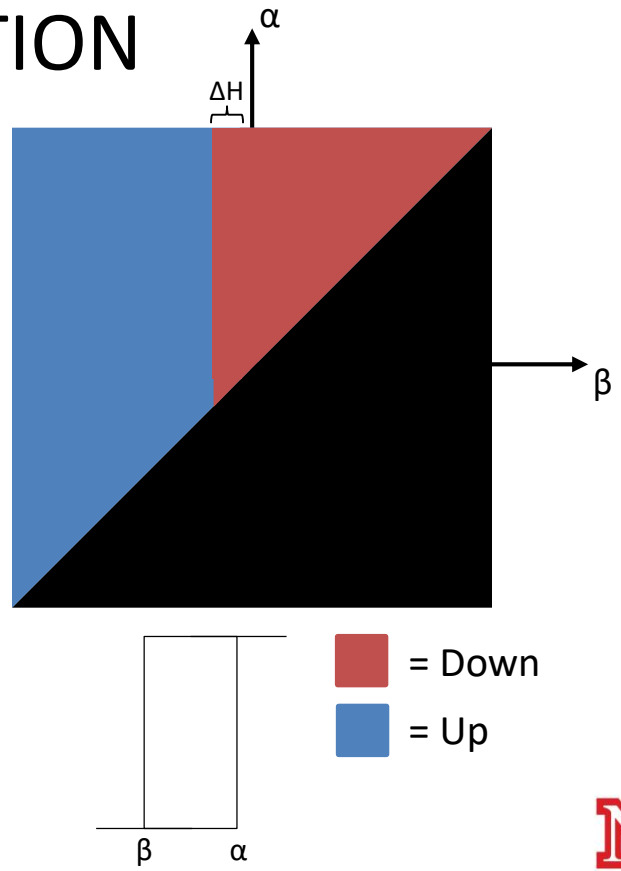
$\alpha\beta$-PLANE

- Representation of hysterons with pairs (α,β) and their orientations
  - $\mu(\beta > \alpha) = 0$ for physical systems
  - Start at *positive* saturation: all hysterons point up
  - Sweep field down to saturation: hysterons with highest α flip first
  - Field up to saturation: hysterons with lowest α flip first

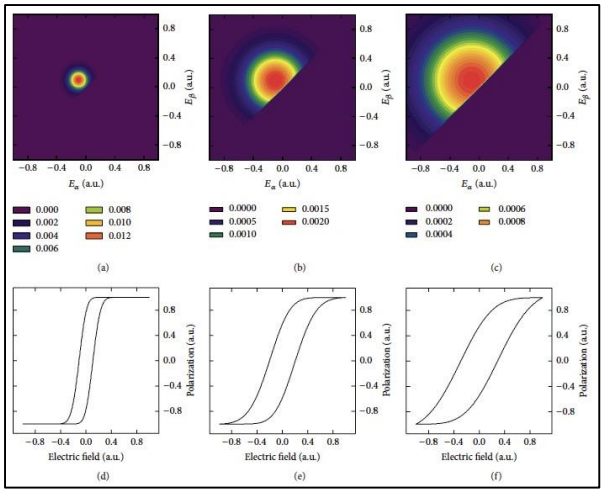


RECONSTRUCT DENSITY FUNCTION

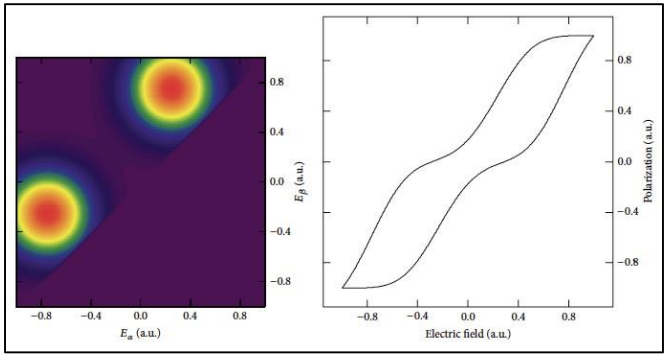
- In small ΔH, # of hysterons flipped relates to loop's derivative
  - Get a 1-dimensional view of the axis (e.g. scan down gives projection of β-axis)
  - Use scan down, scan up, and symmetry to approximate PDF



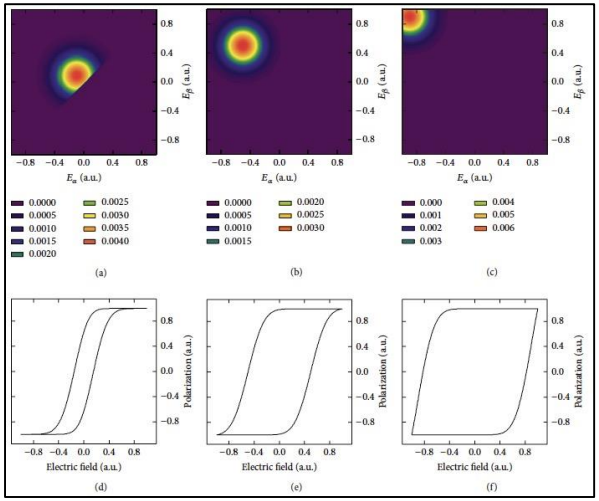
FEATURES OF PDFS



Wider distribution: less square loops



Bimodal:



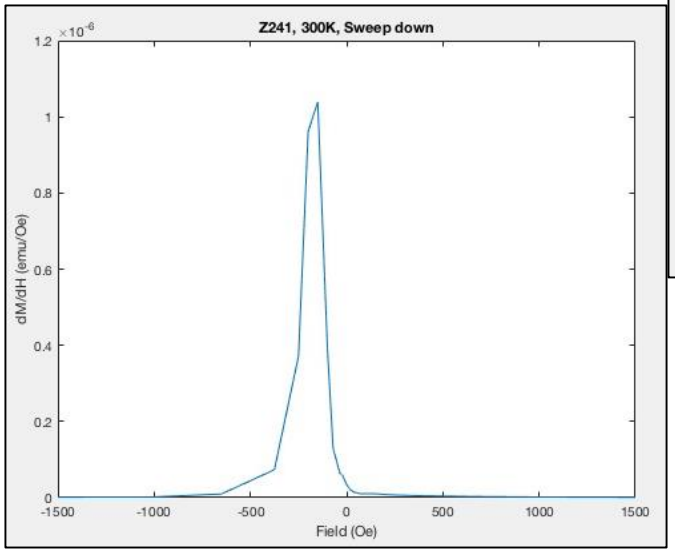
Further from origin: wider loops

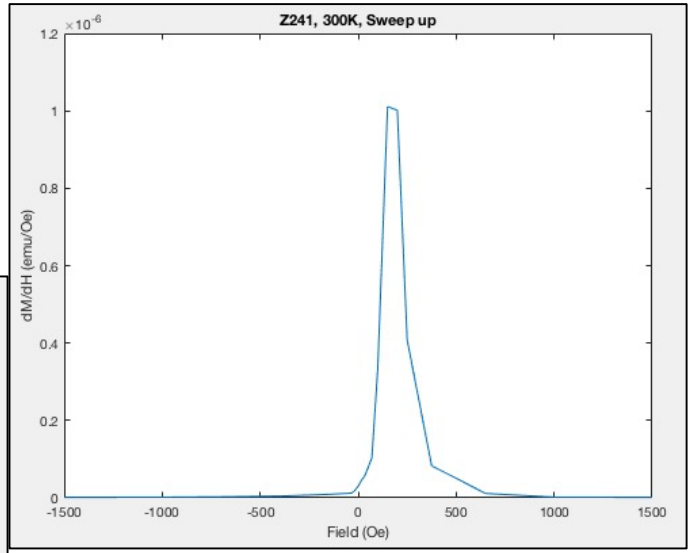
Monnor, Laosiritaworn, Yimnirun, Advances in Condensed Matter Physics, 2013. http://dx.doi.org/10.1155/2013/959134

WRITING THE CODE

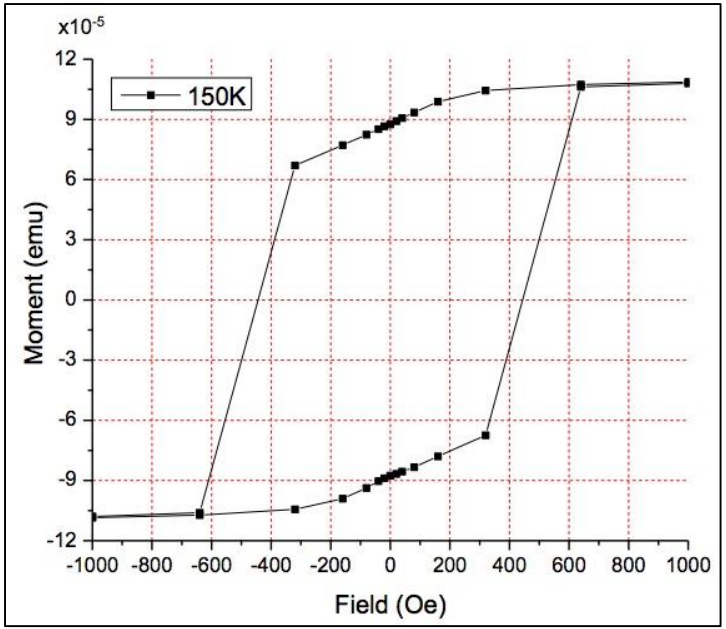
MATLAB code to approximate derivatives

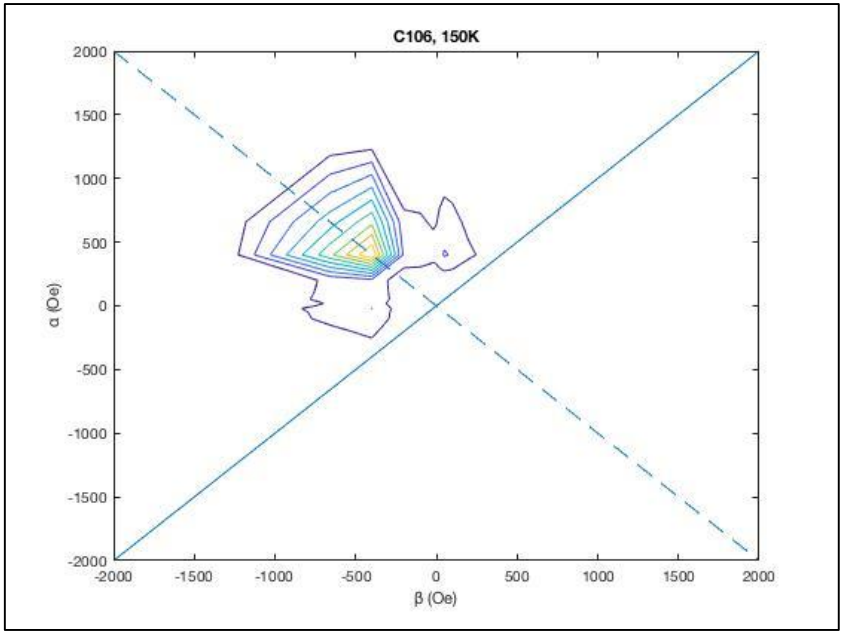
Multiply 1d plots to get back 2d table of α-β plane, plot in MATLAB.



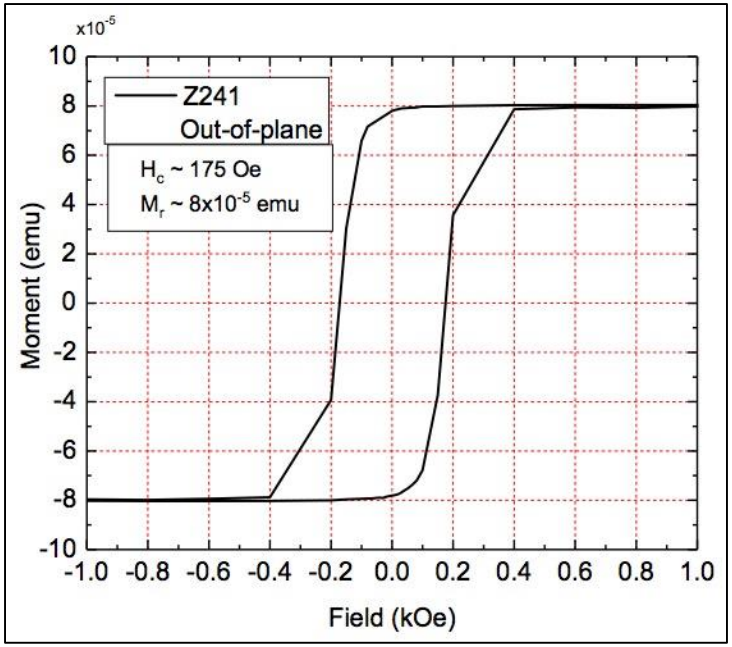


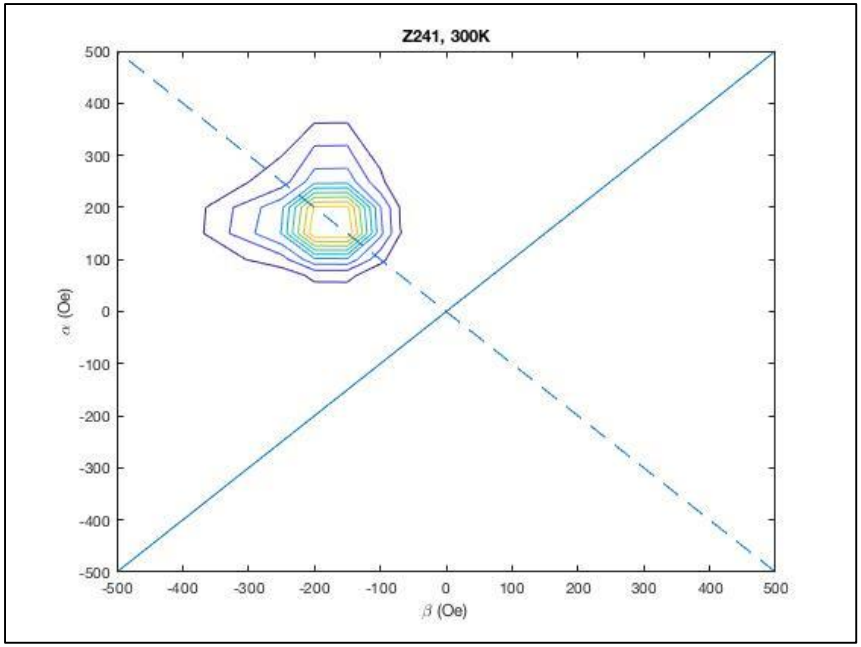
SOME RESULTS: C106



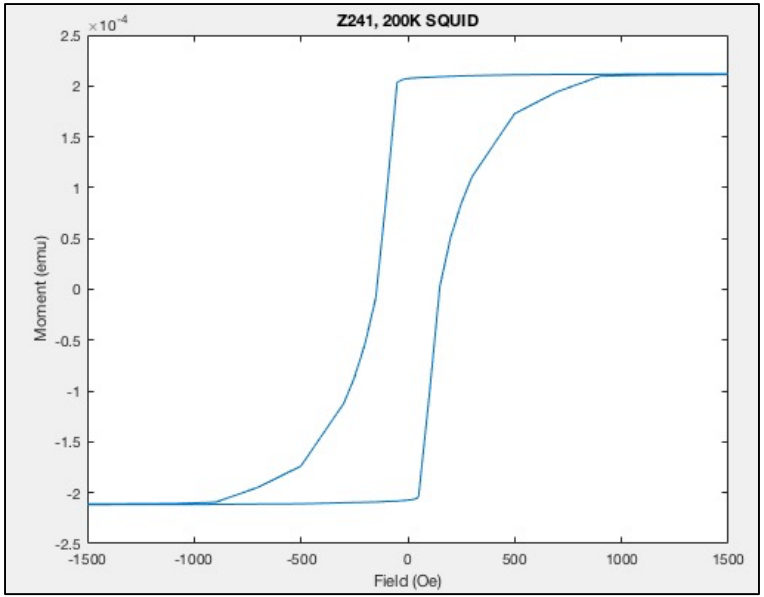


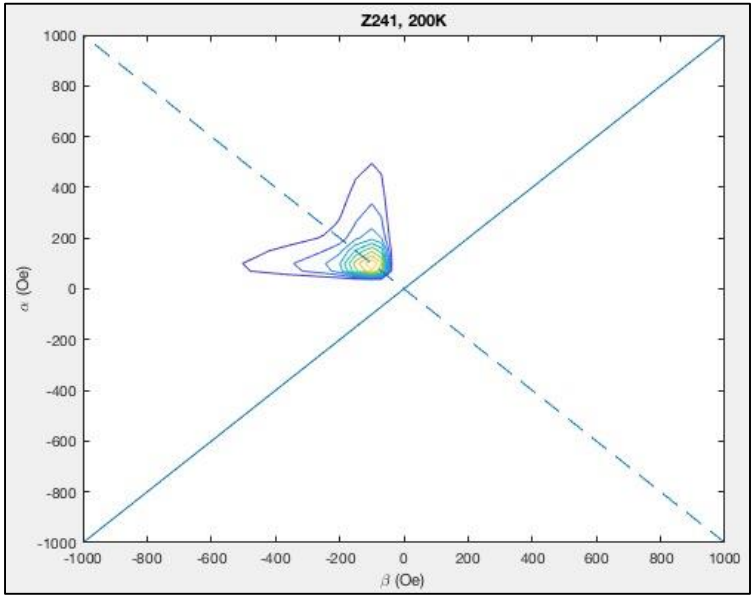
SOME RESULTS: Z241 @ RT (SQUARE LOOP)



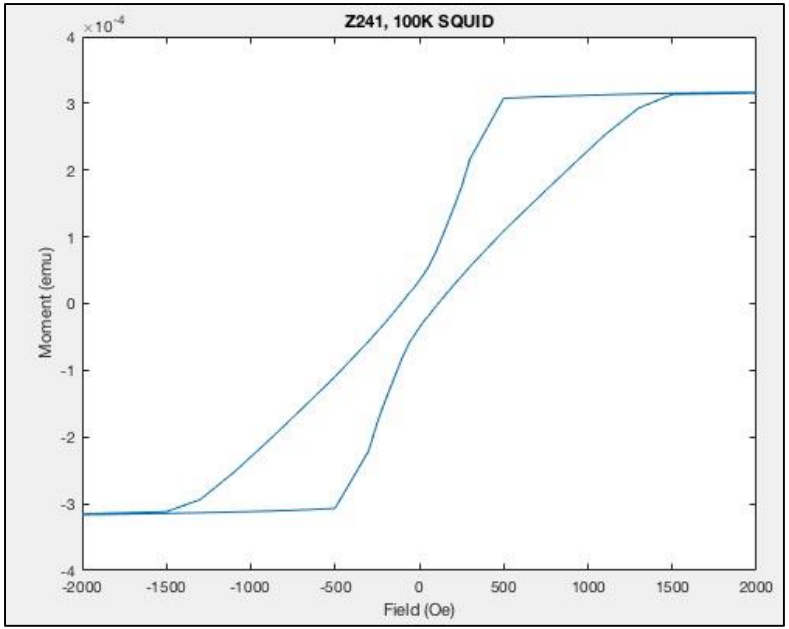


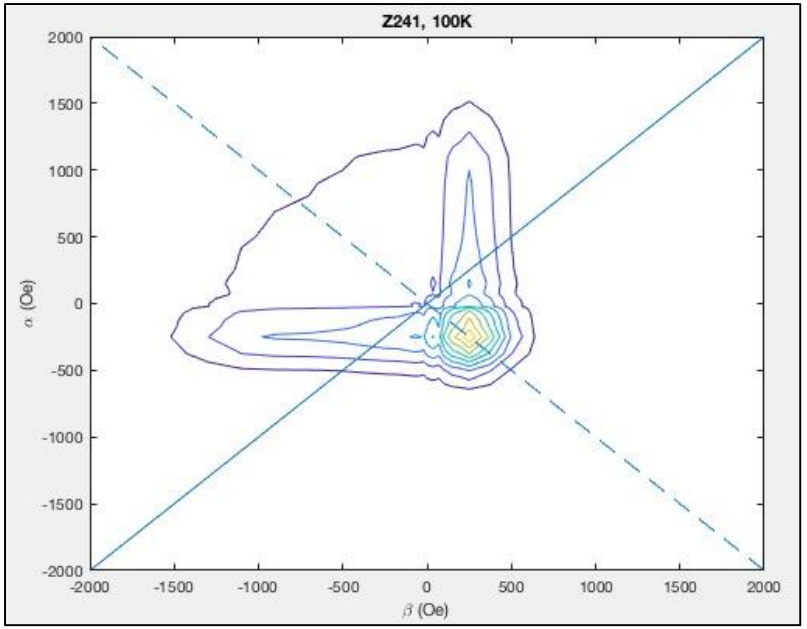
SOME RESULTS: Z241 AT 200K



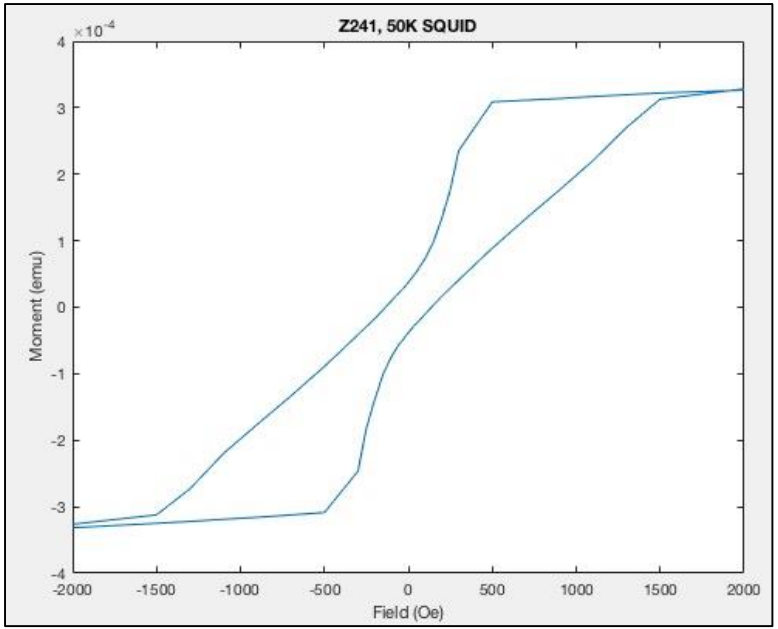


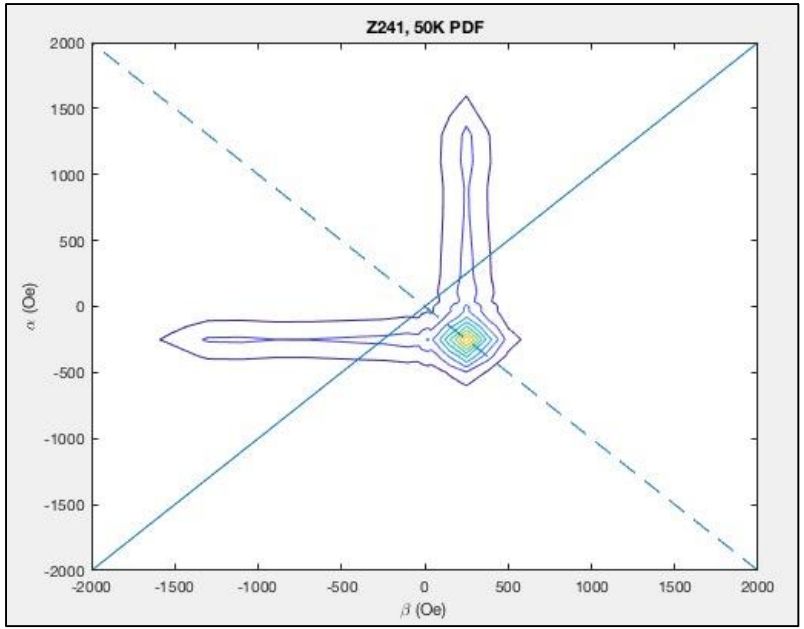
SOME RESULTS: Z241 AT 100K





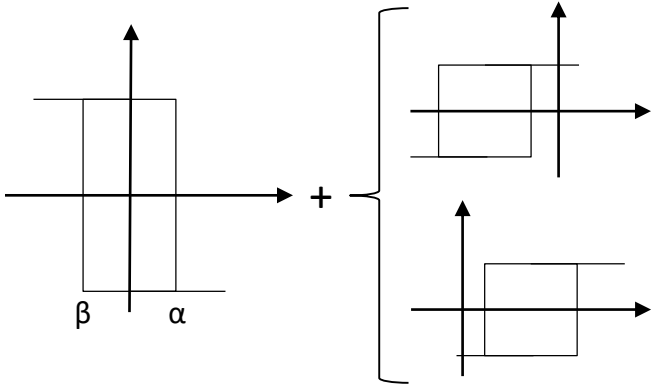
SOME RESULTS: Z241 AT 50K

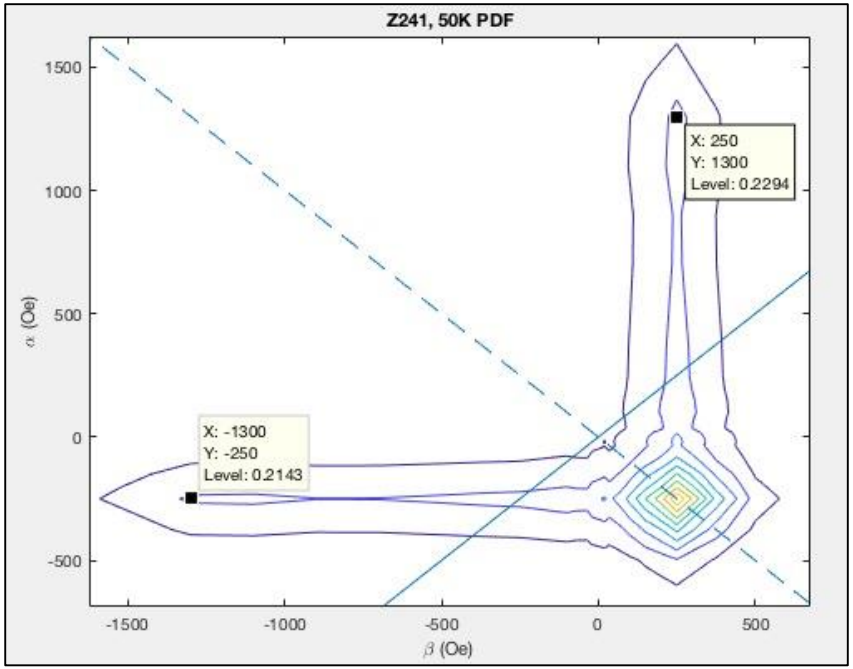




HOW TO INTERPRET THESE?

- High density of loops with β=-α=250 Oe, lower density towards fringes (~20% rel. intensity)





THANKS!