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14. ABSTRACT
A major paradigm in contemporary biomechanics is the use of perturbation studies to probe animal movement. Such studies either implicitly or explicitly compare perturbed animal motions to some estimate of how an unperturbed animal would move. For cyclic motion, often encountered in locomotion studies, a common Null hypothesis is that animals continue moving as before. Our ability to resolve changes is often limited by the predictive capabilities of our Null model, themselves dependent on our ability to capture inter-individual variation and cycle to cycle variability. The mathematics of dynamical systems teaches us that a model based on the "asymptotic phase" of the

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Report Title

Phase driven models of unperturbed locomotion

ABSTRACT

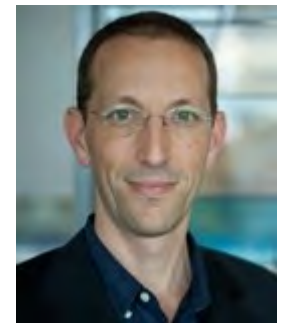
A major paradigm in contemporary biomechanics is the use of perturbation studies to probe animal movement. Such studies either implicitly or explicitly compare perturbed animal motions to some estimate of how an unperturbed animal would move. For cyclic motion, often encountered in locomotion studies, a common Null hypothesis is that animals continue moving as before. Our ability to resolve changes is often limited by the predictive capabilities of our Null model, themselves dependent on our ability to capture inter-individual variation and cycle to cycle variability. The mathematics of dynamical systems teaches us that a model based on the “asymptotic phase” of the cyclic motion should have superior statistical properties. Such models have been used for perturbation studies [Revzen-SICB-2005, Revzen-BioCyber-2013], and have used phase estimation techniques designed with the assumption that animal motions are close to some idealised cycle. In attempting to study the responses of animals to large perturbations, and the transition between different animal gaits [Wilshin-SICB-2012] we encounter the need to estimate phase for motions far removed from this idealised cycle. We present a method for obtaining the phase of cyclic movement which does not require the testing data be close to the limit cycle. Training data may consist of cycle fragments of any length, provided they cover the range of motions to be analysed. We show how this results in tighter confidence intervals on estimates of unperturbed animal motions. We argue that this approach can be used to provide a better description of phase during a gait transitions and in the study of multistable oscillators.

Phase driven models of unperturbed locomotion

Simon Wilshin^{1,3}, Shai Revzen²

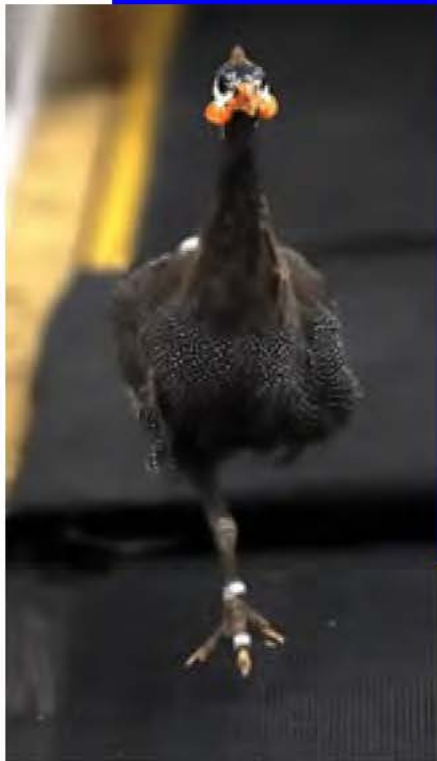
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³swilshin@rvc.ac.uk

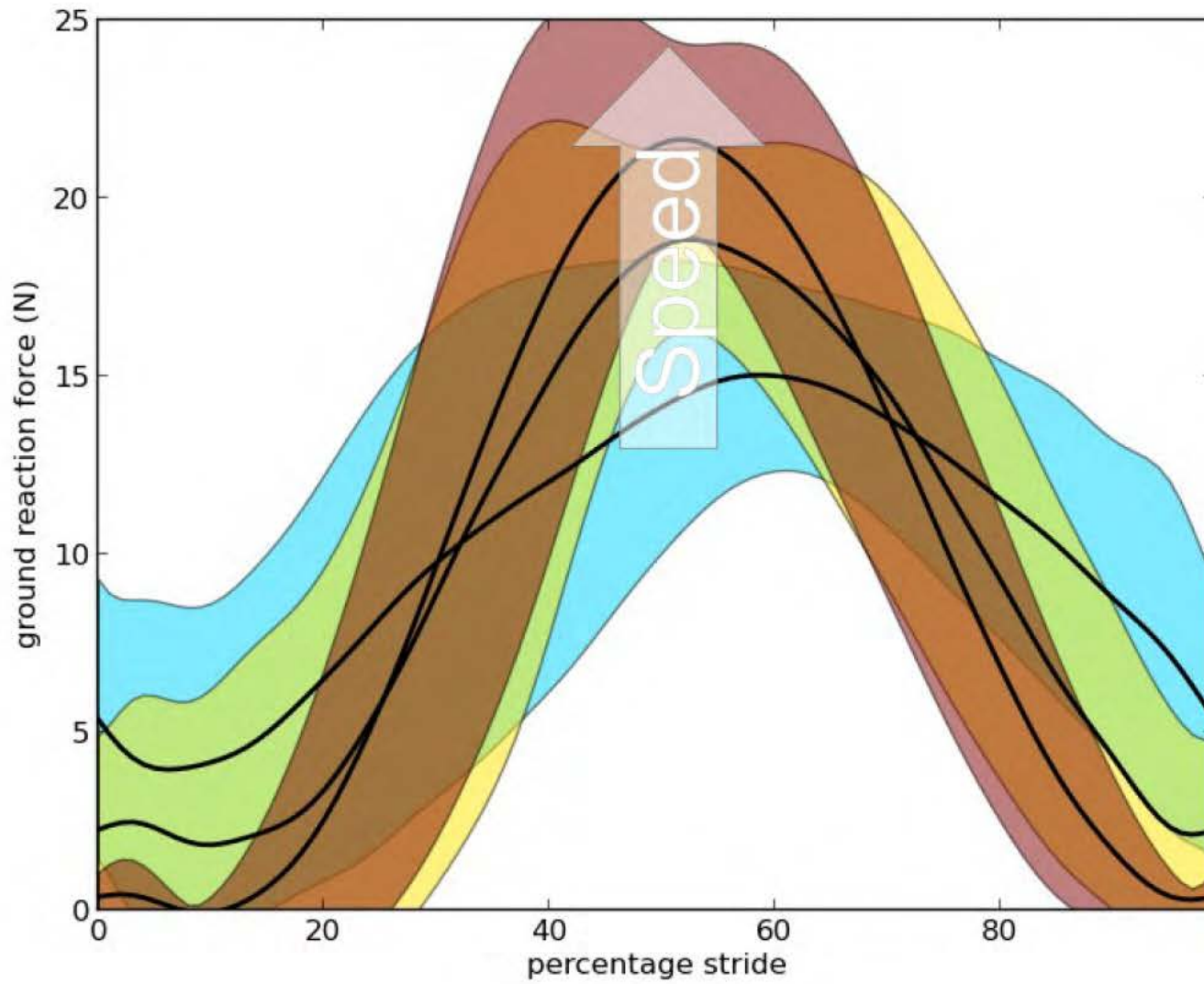


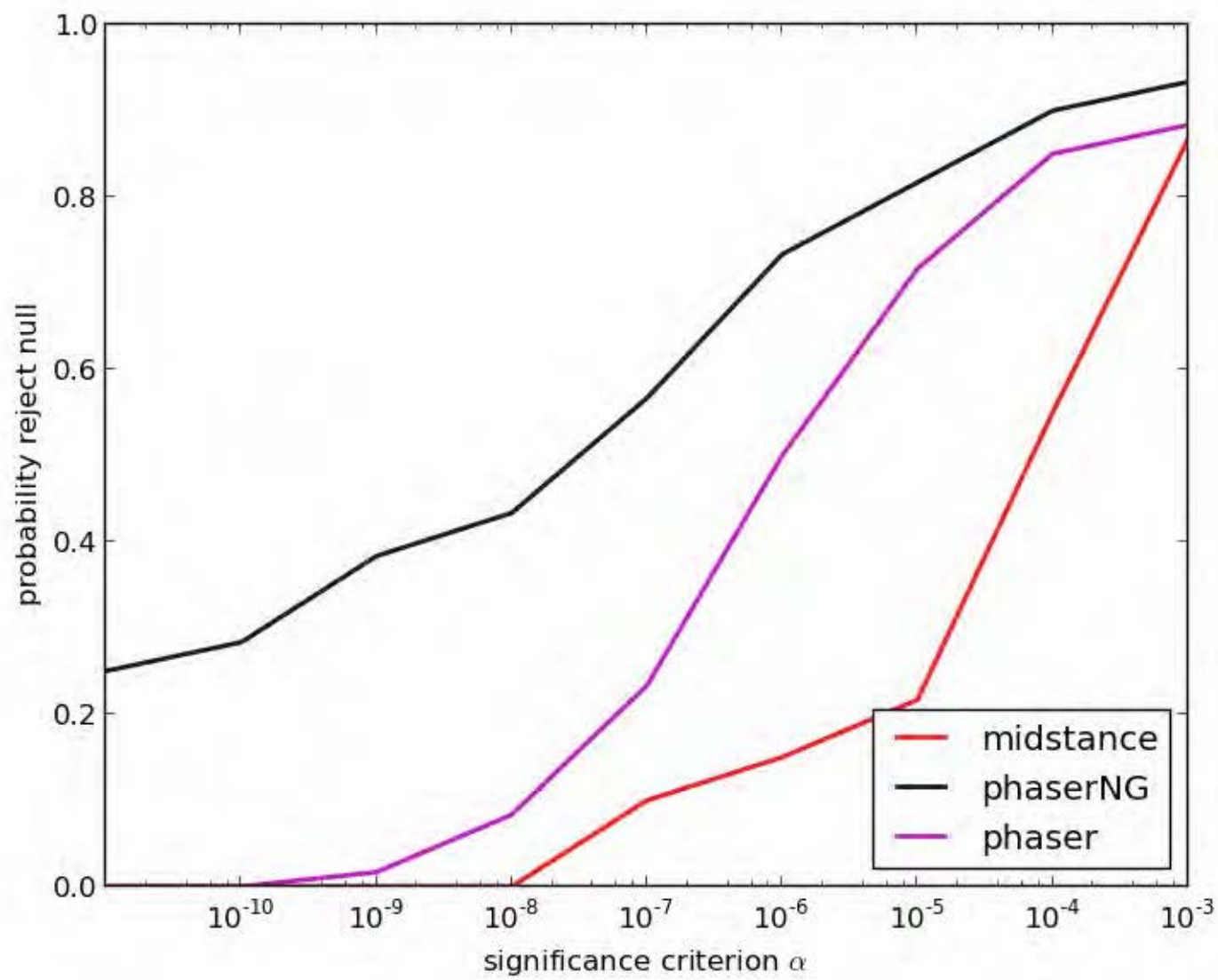
A good estimate of phase lets you detect more effects in your data for less work.

Animation of data, a bird walking with force traces

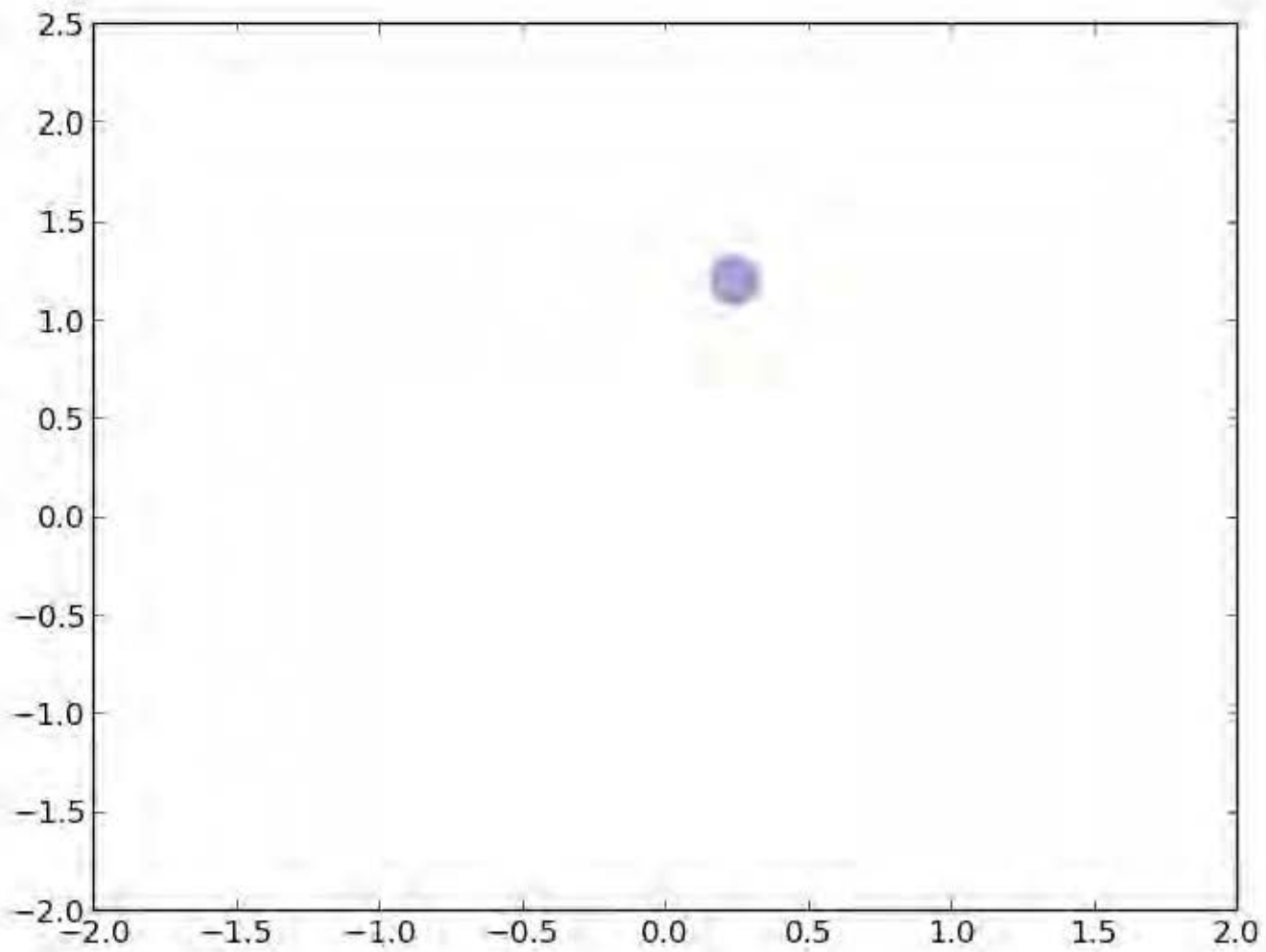


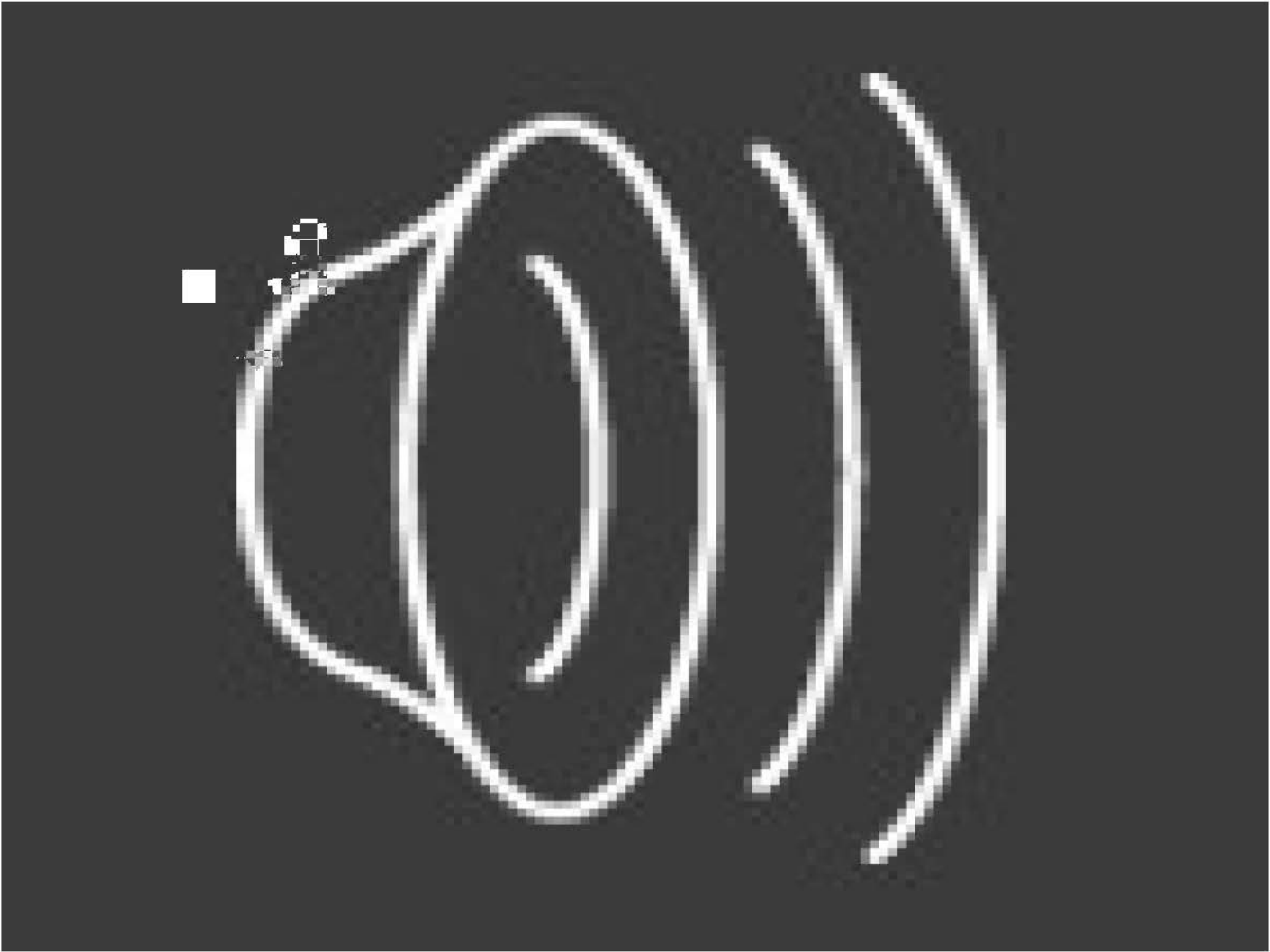
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Yvonne Blum, Jade Hall

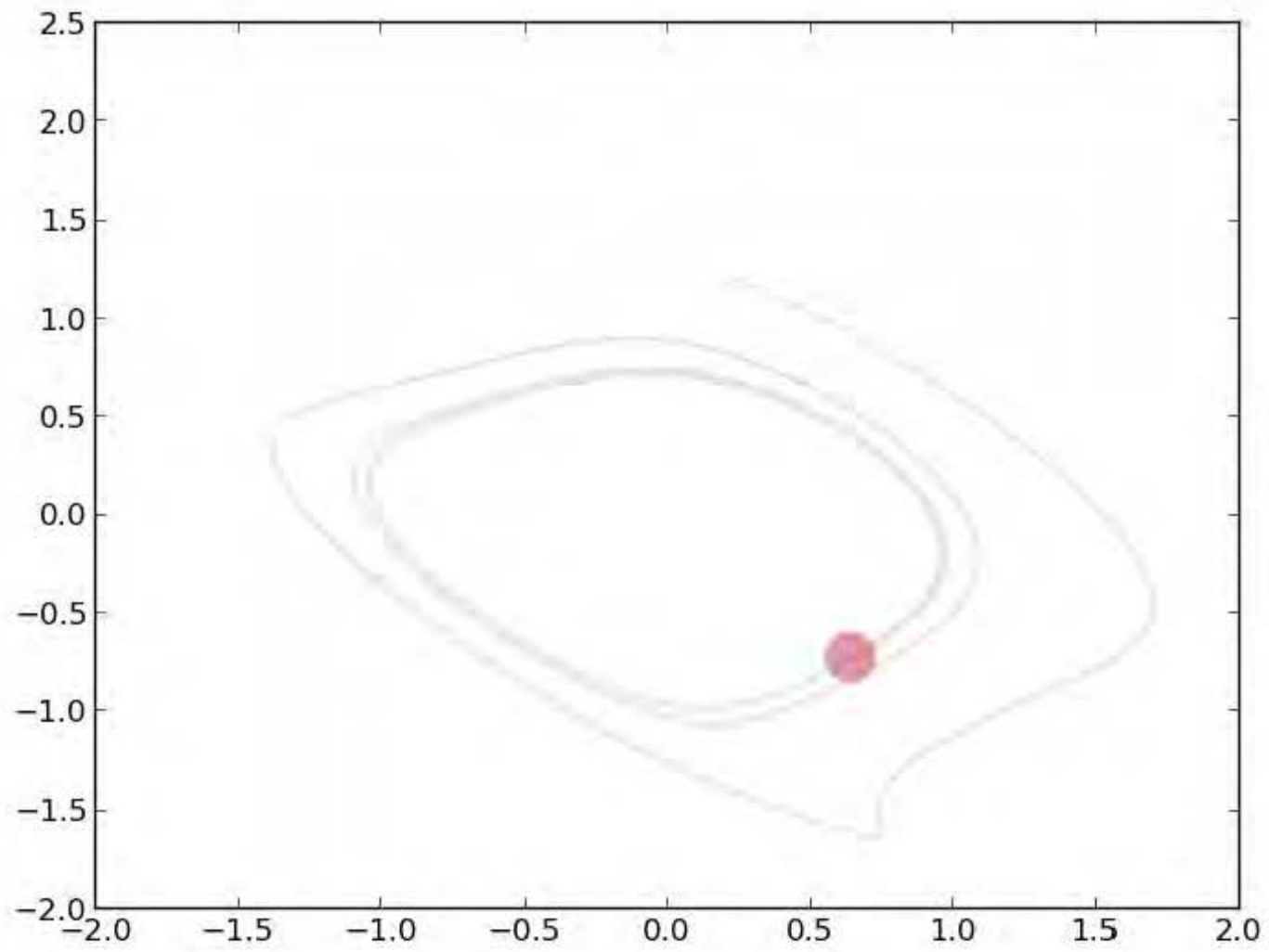


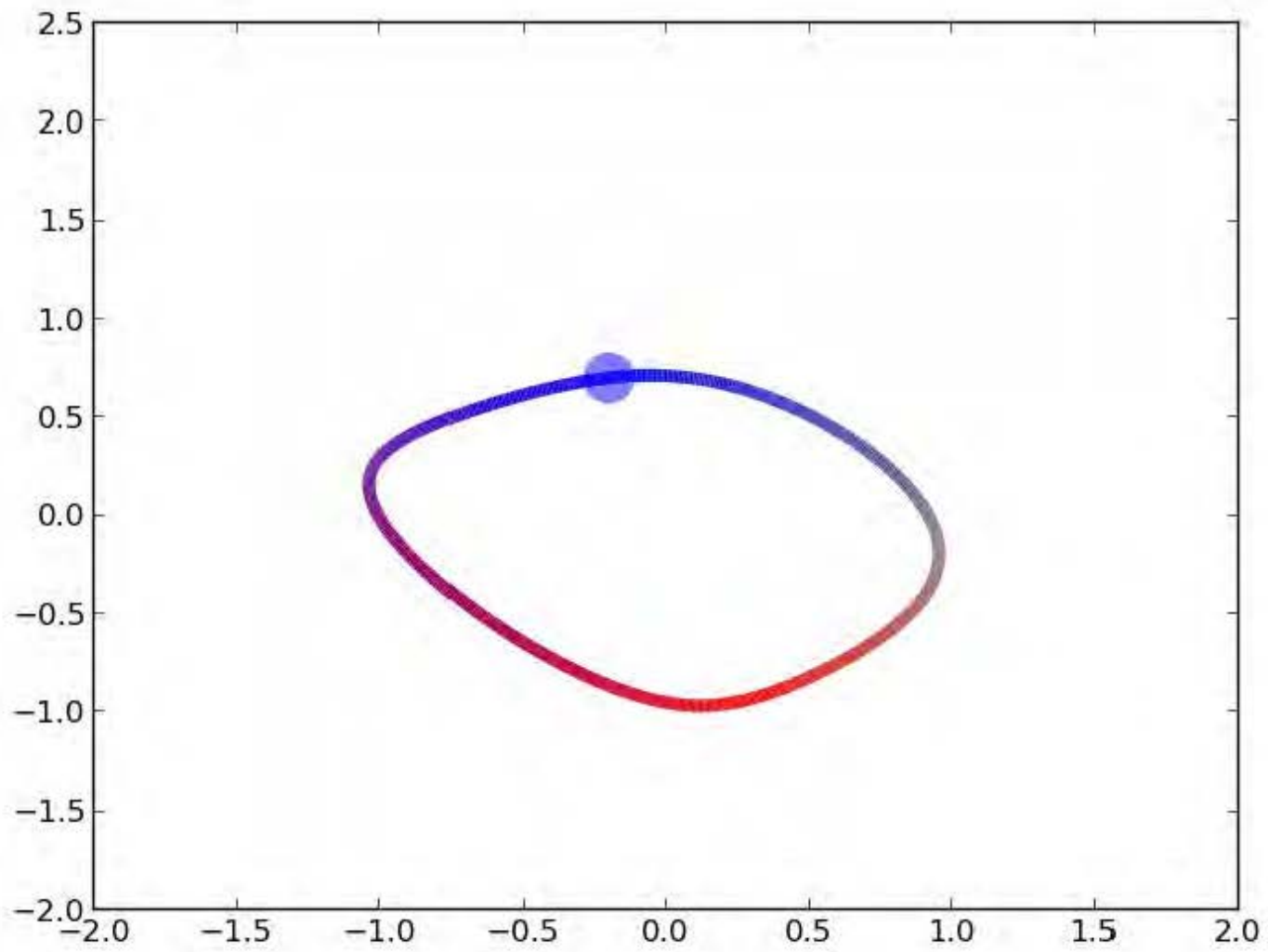


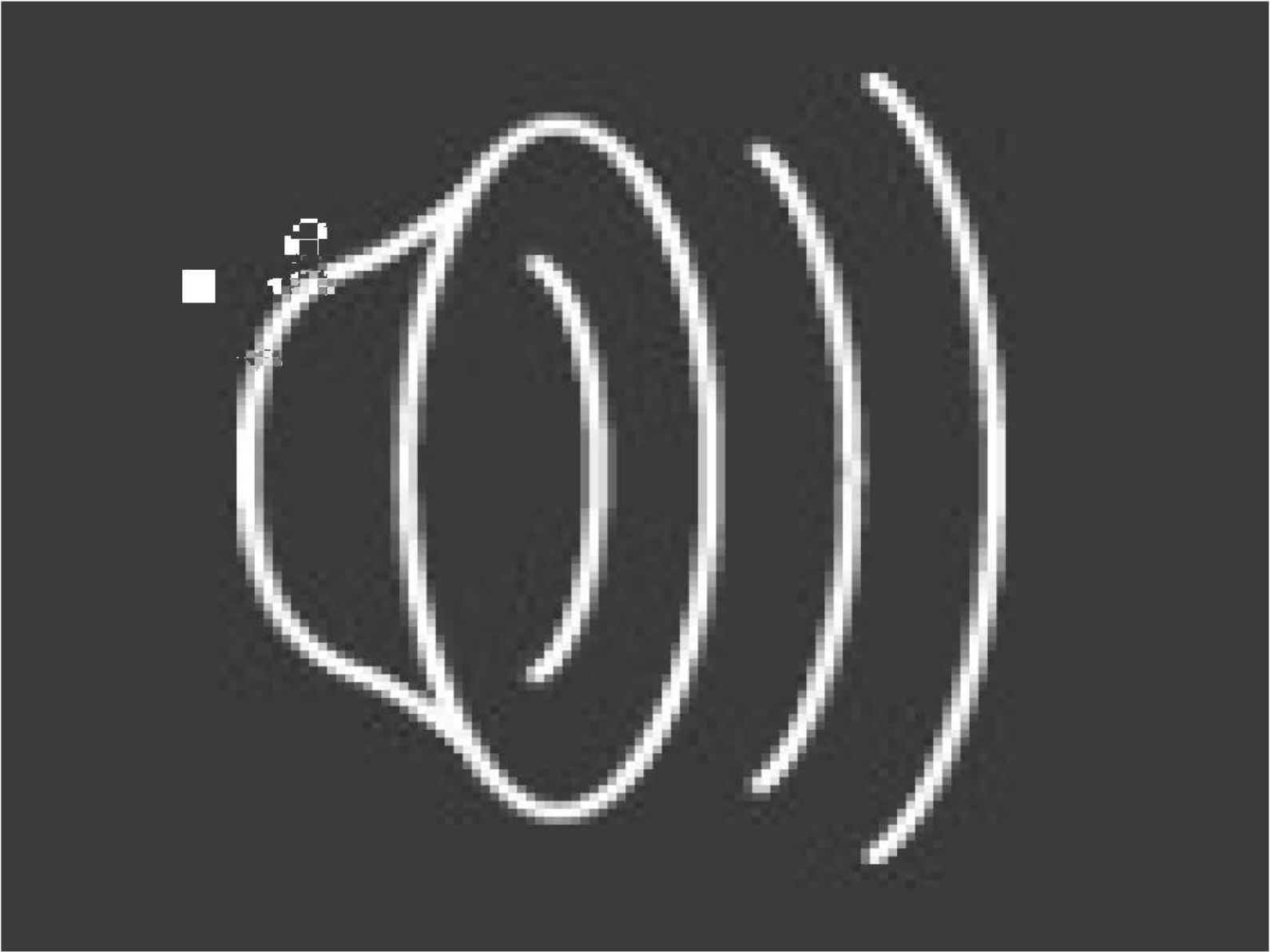
Why Phase?

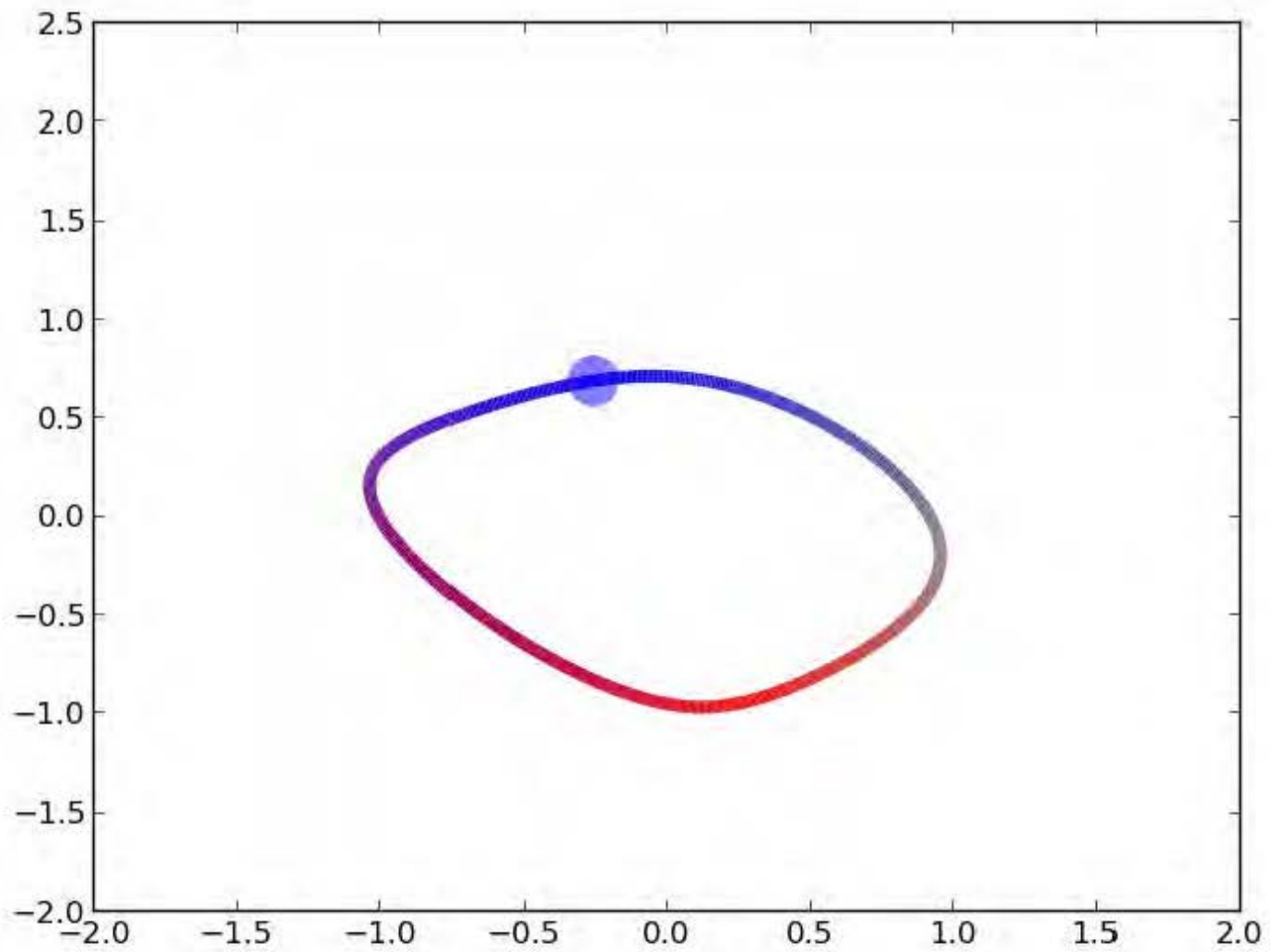


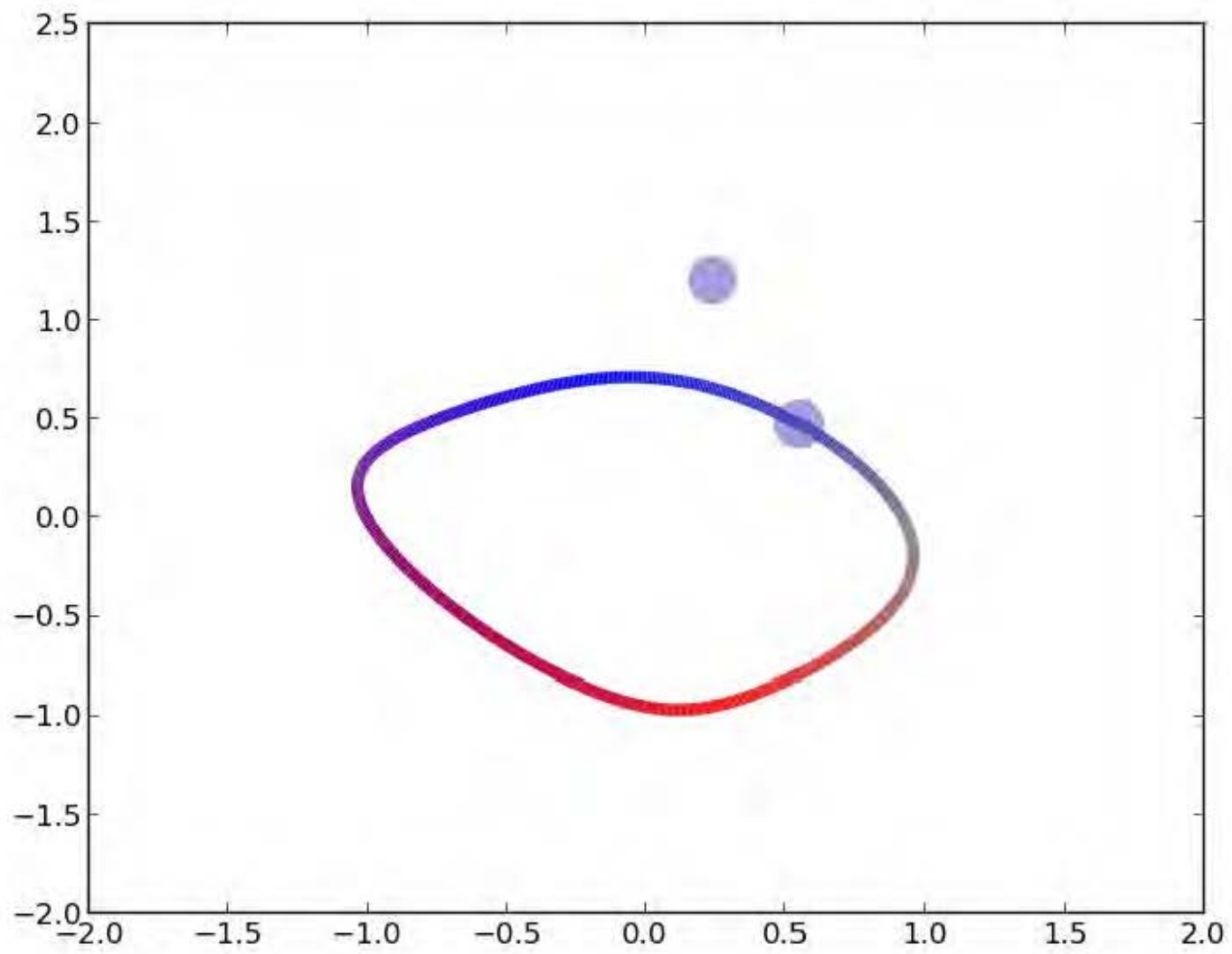




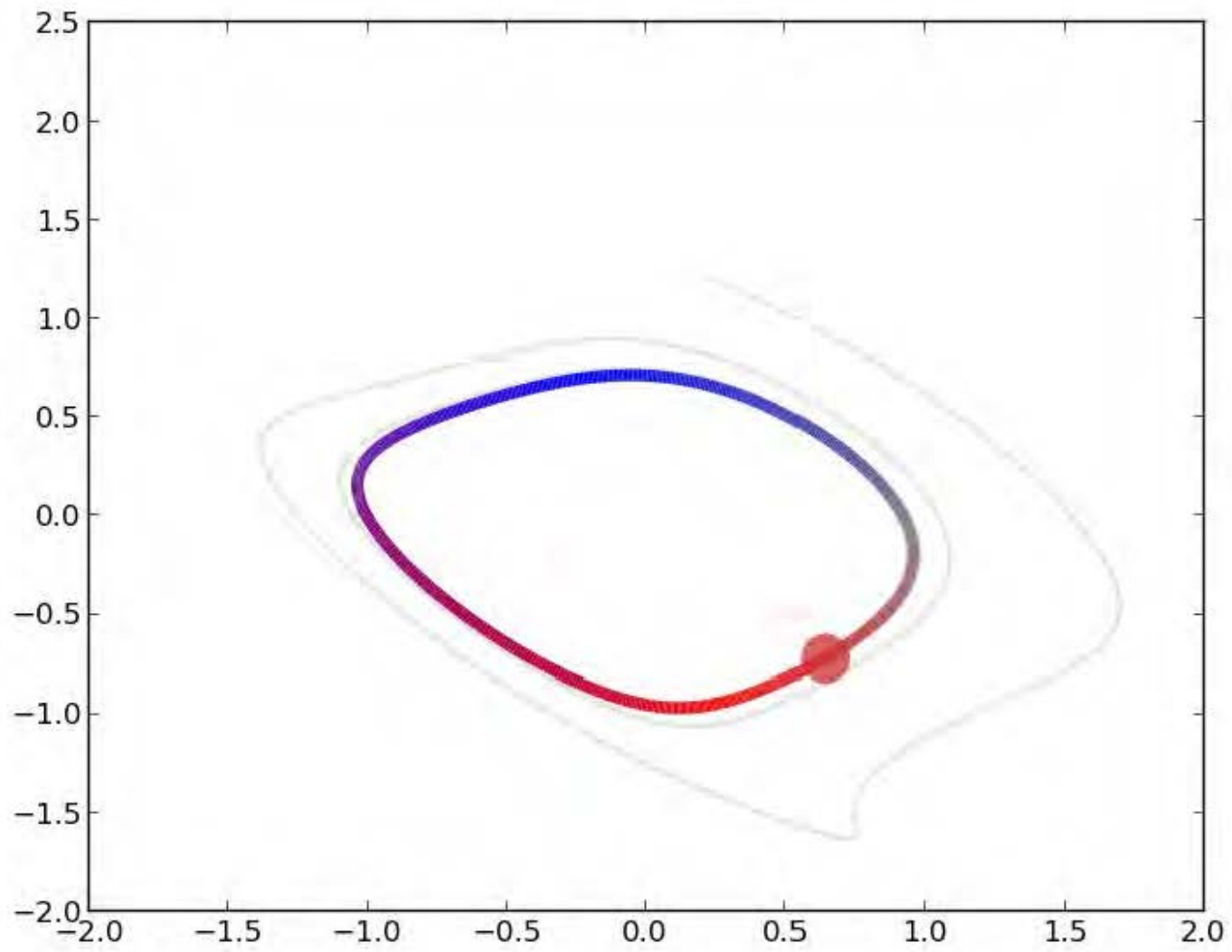


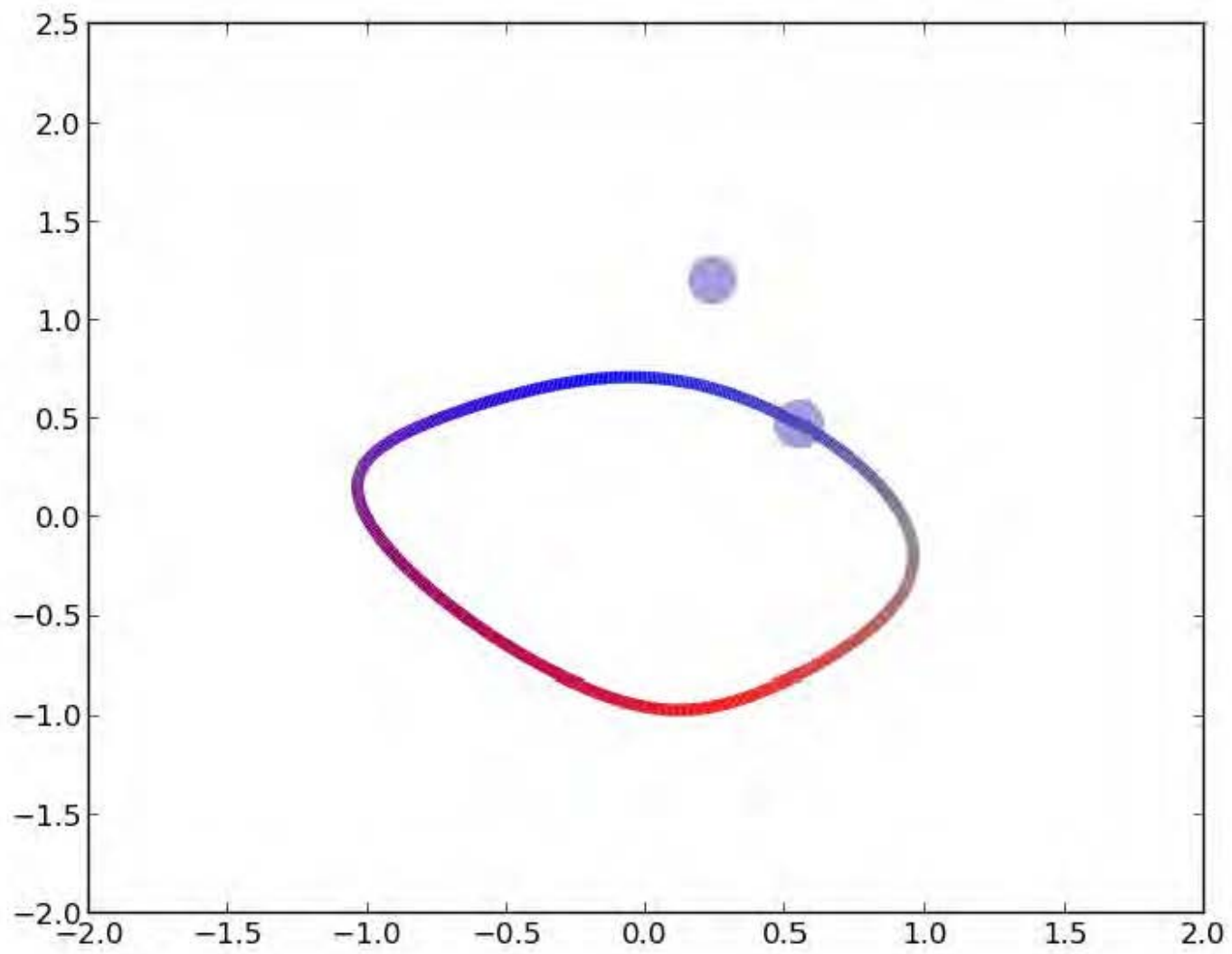


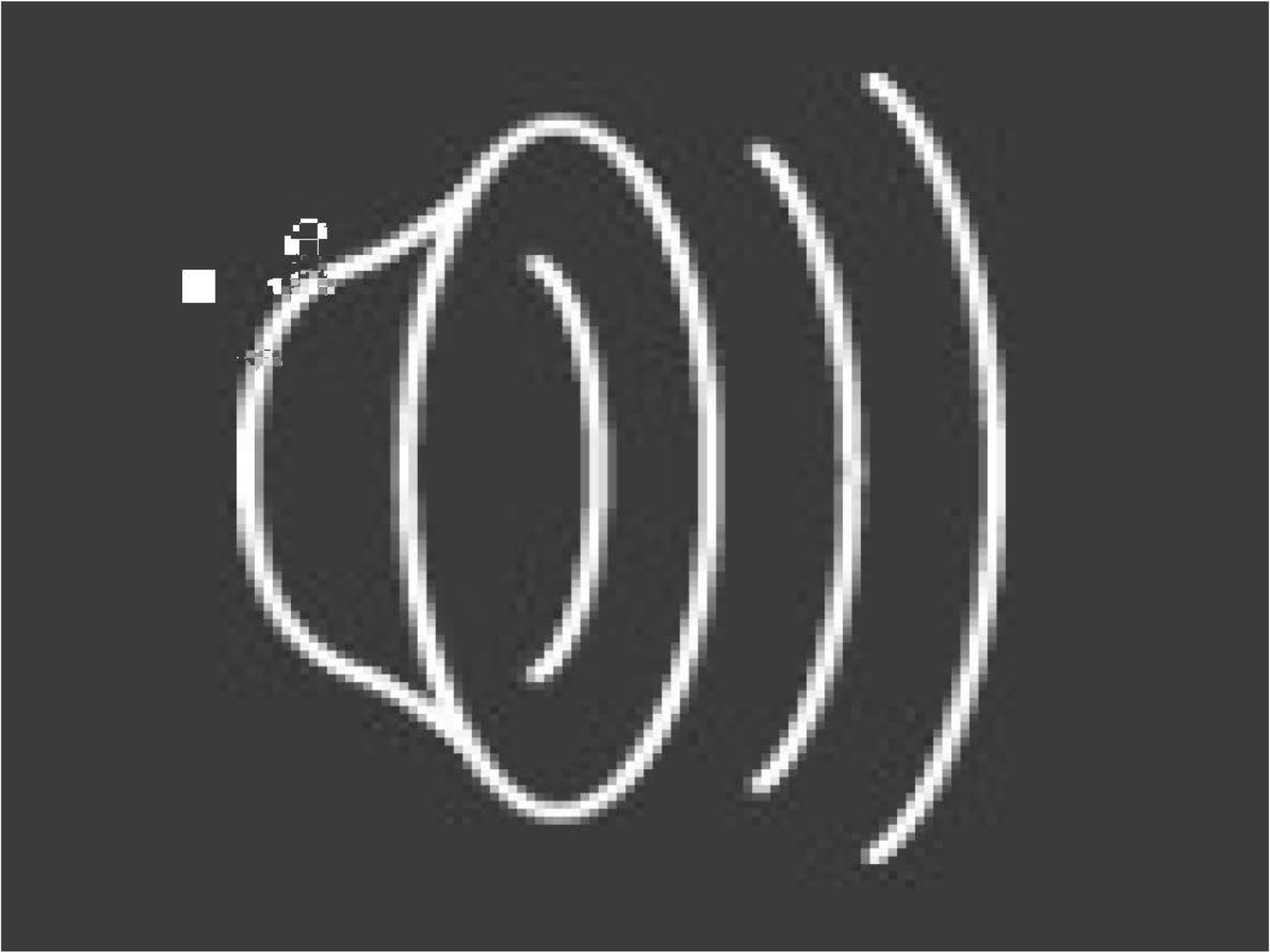


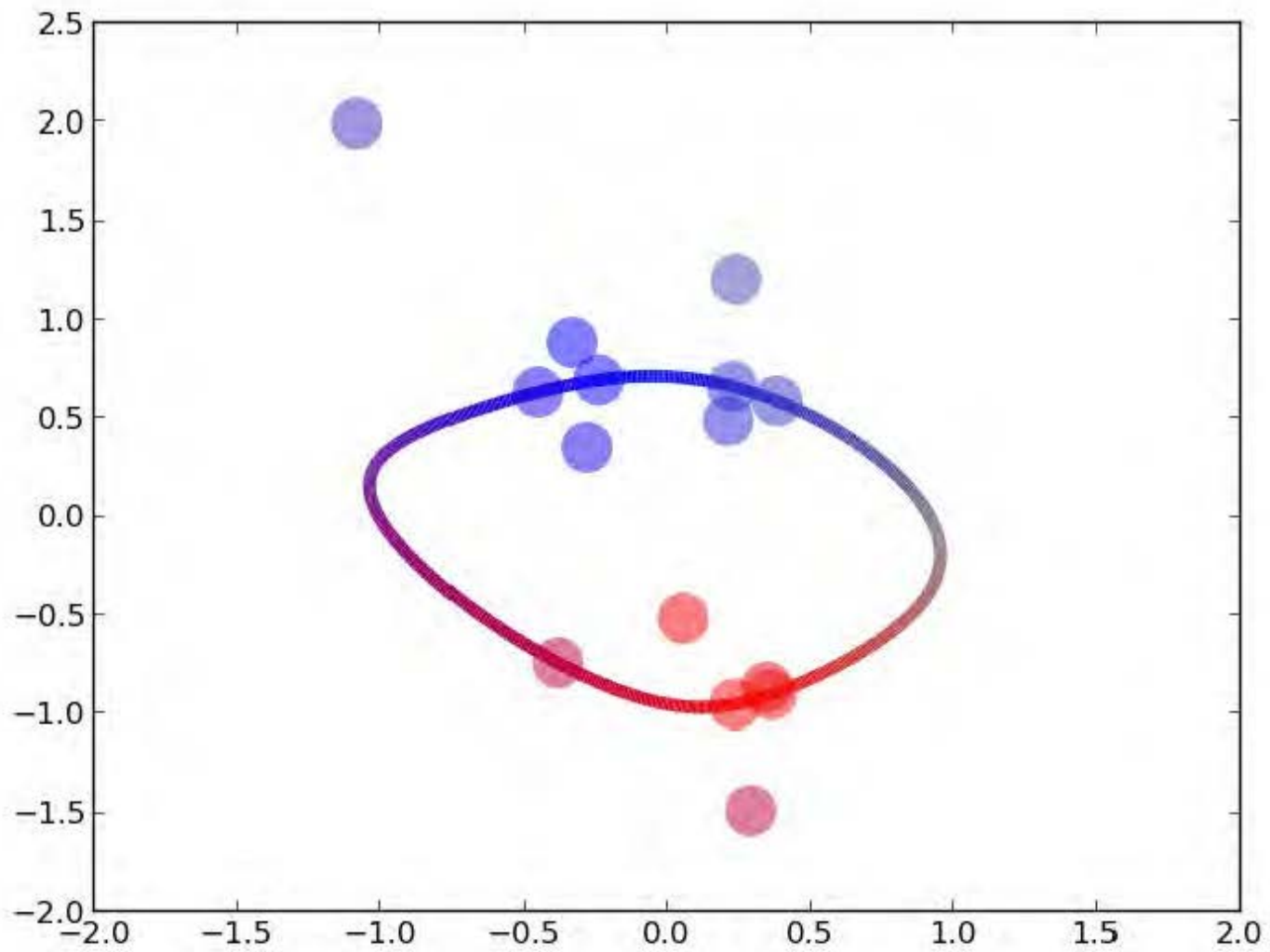


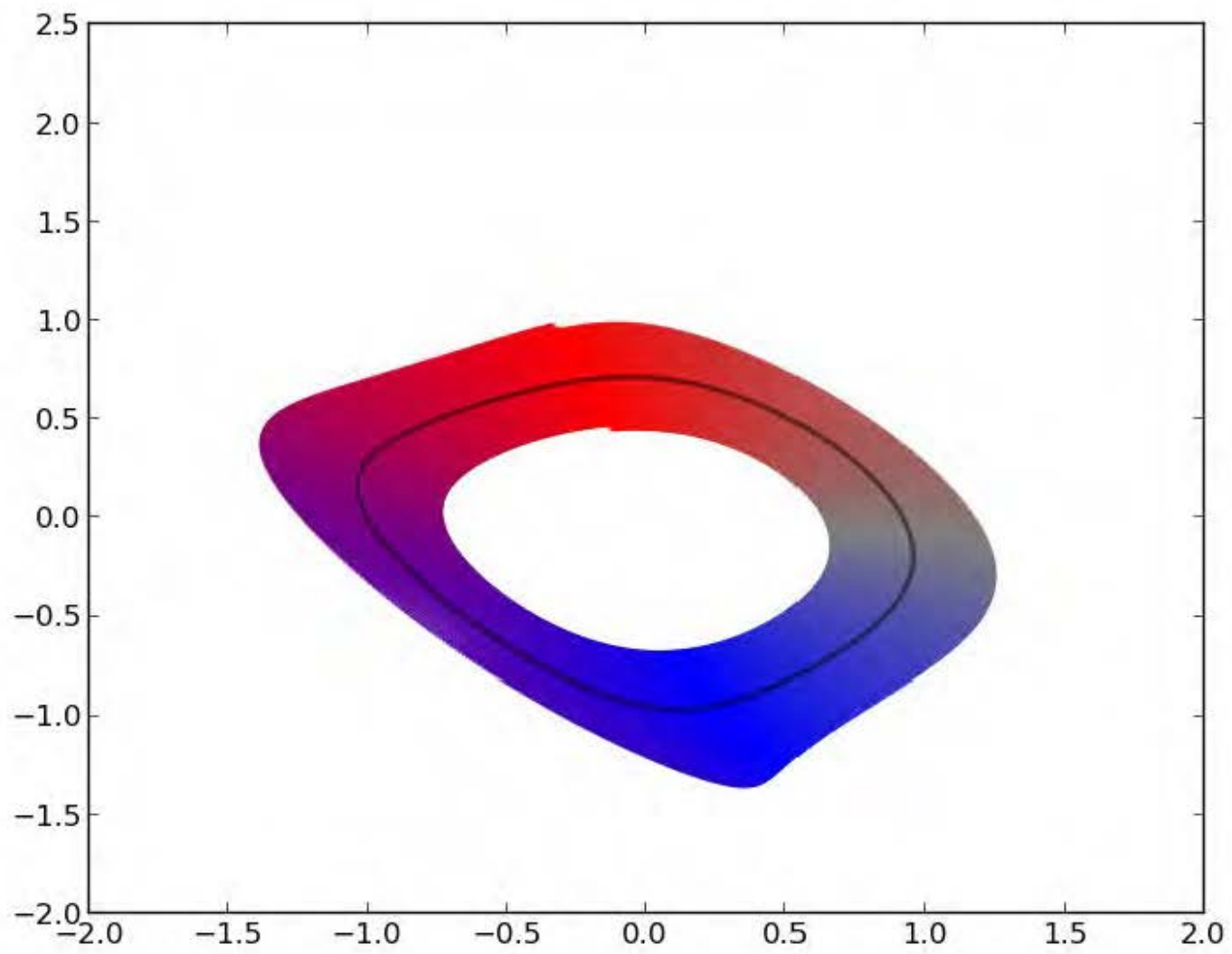


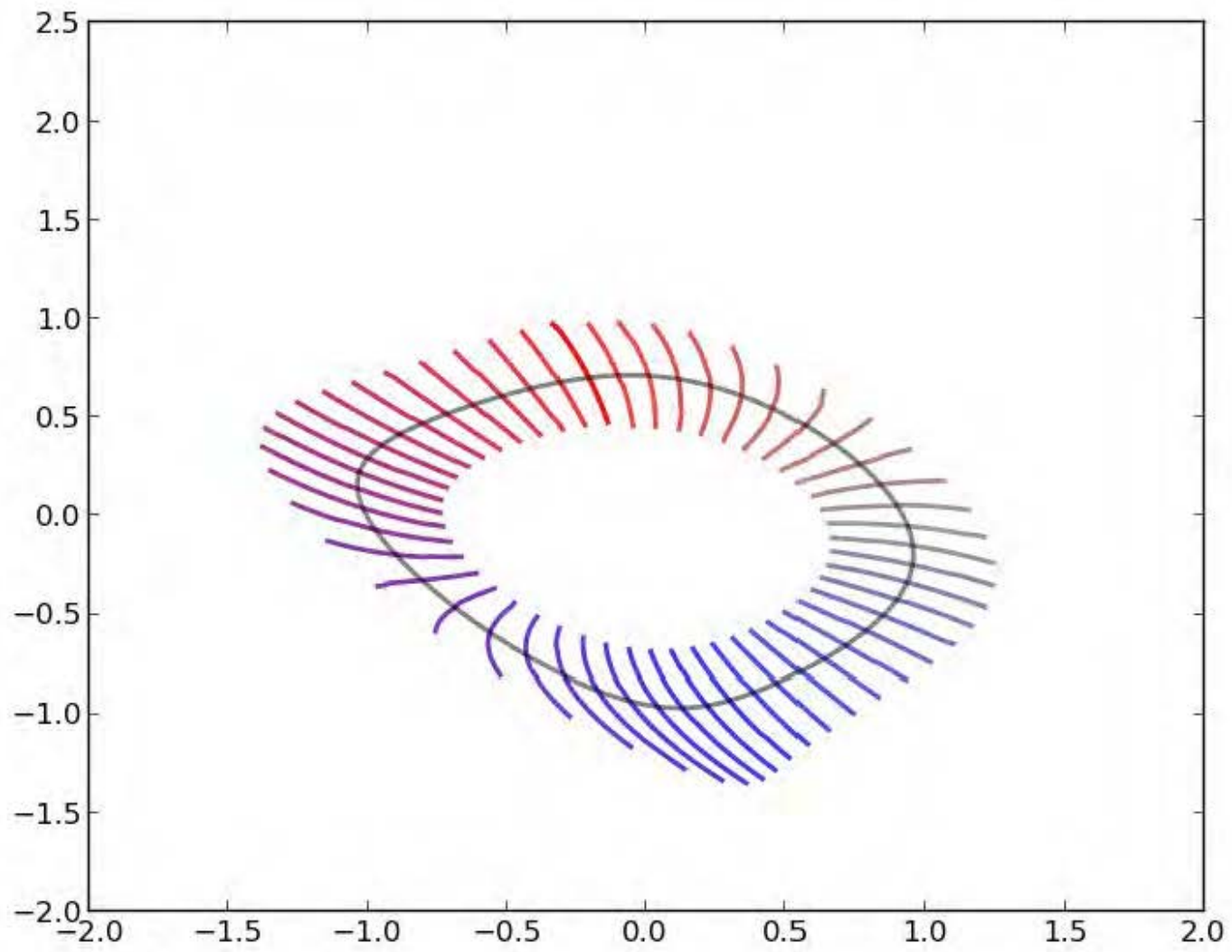


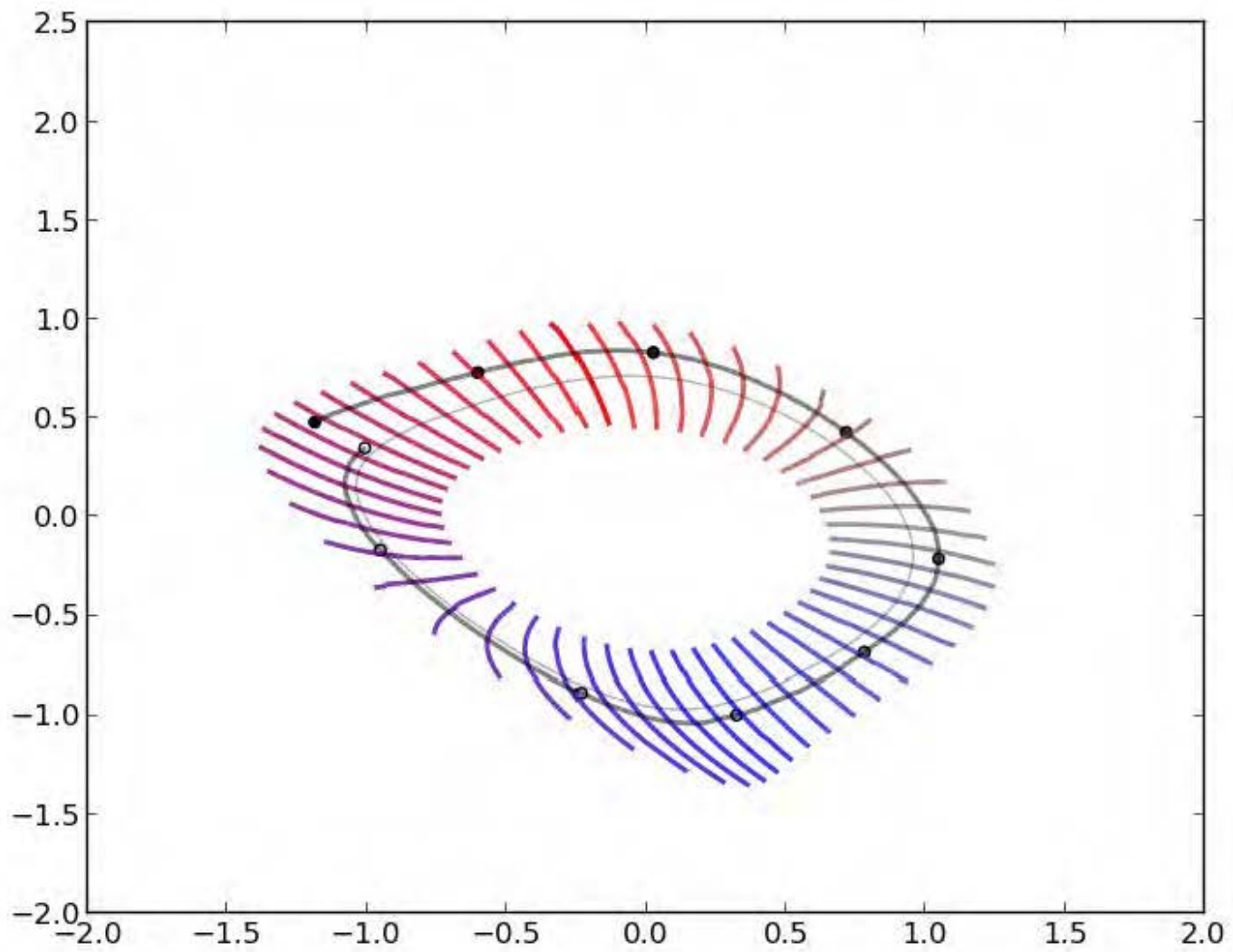


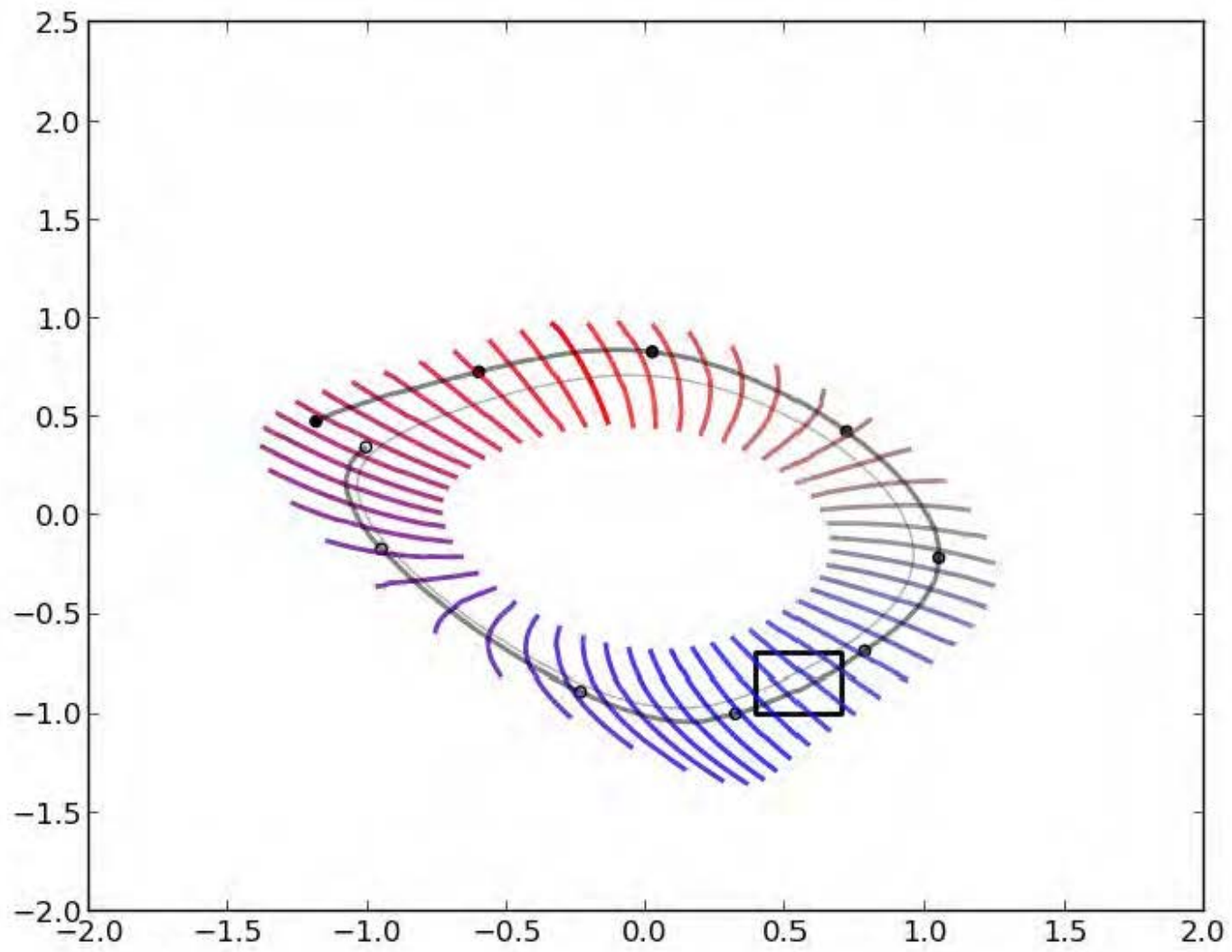


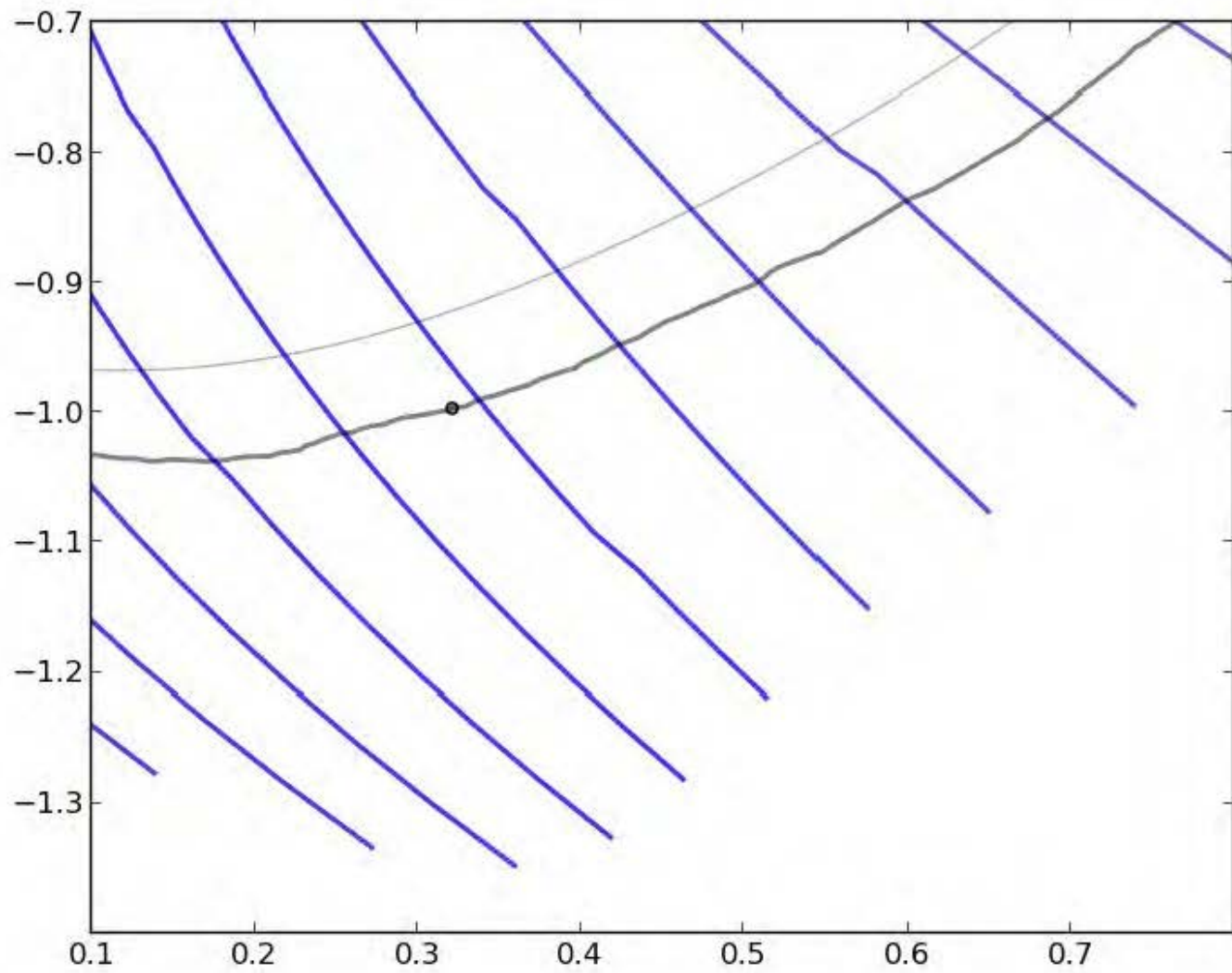


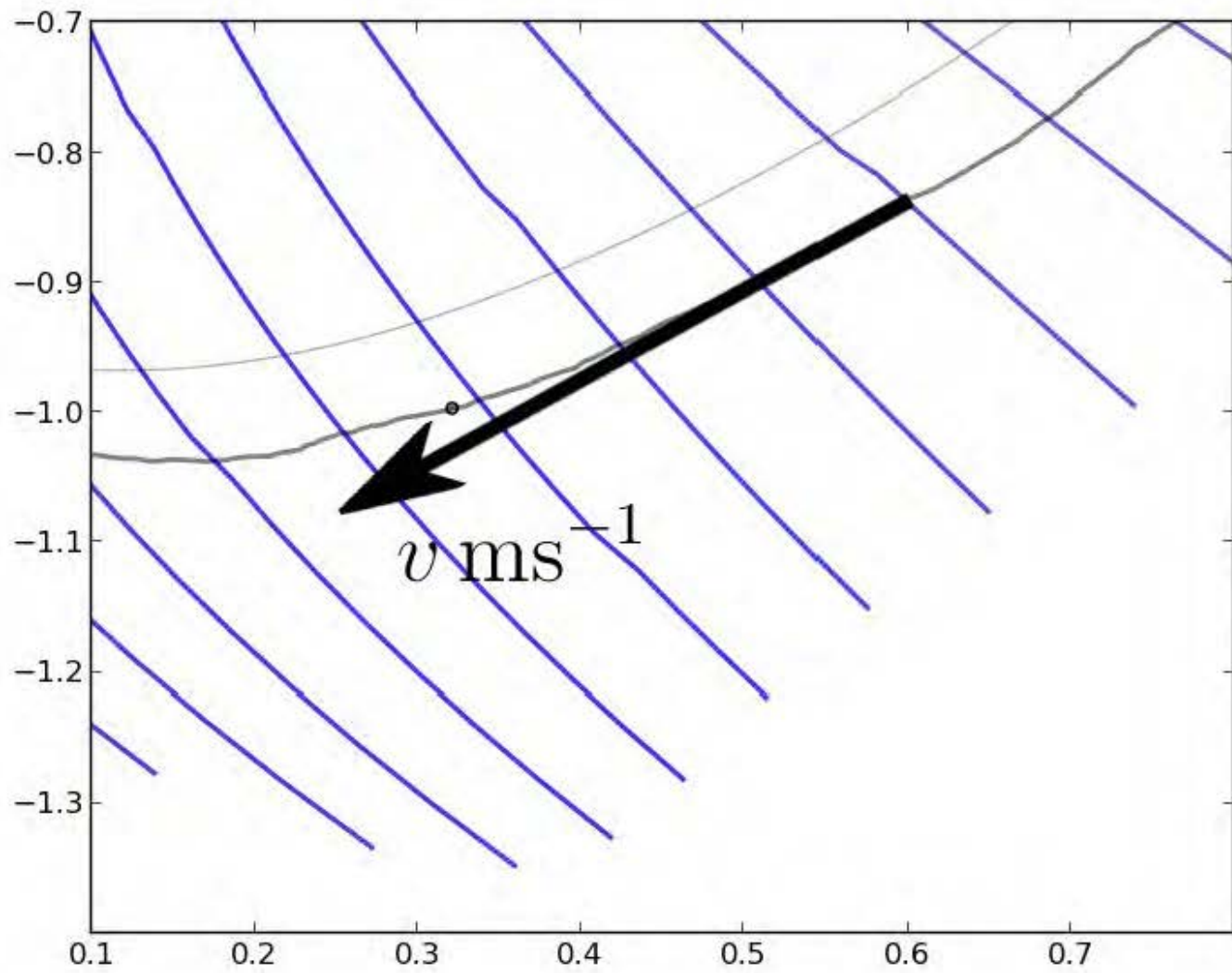


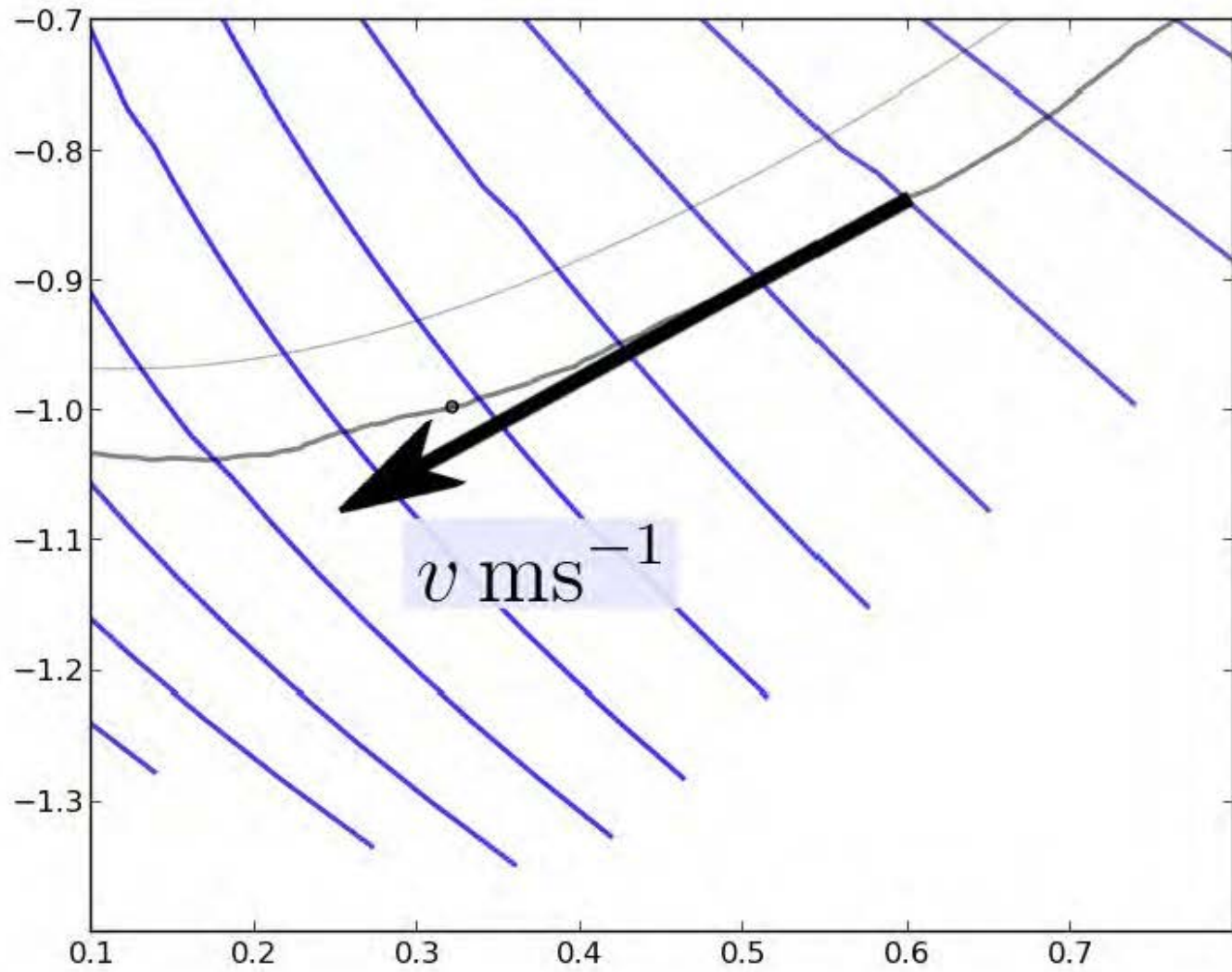


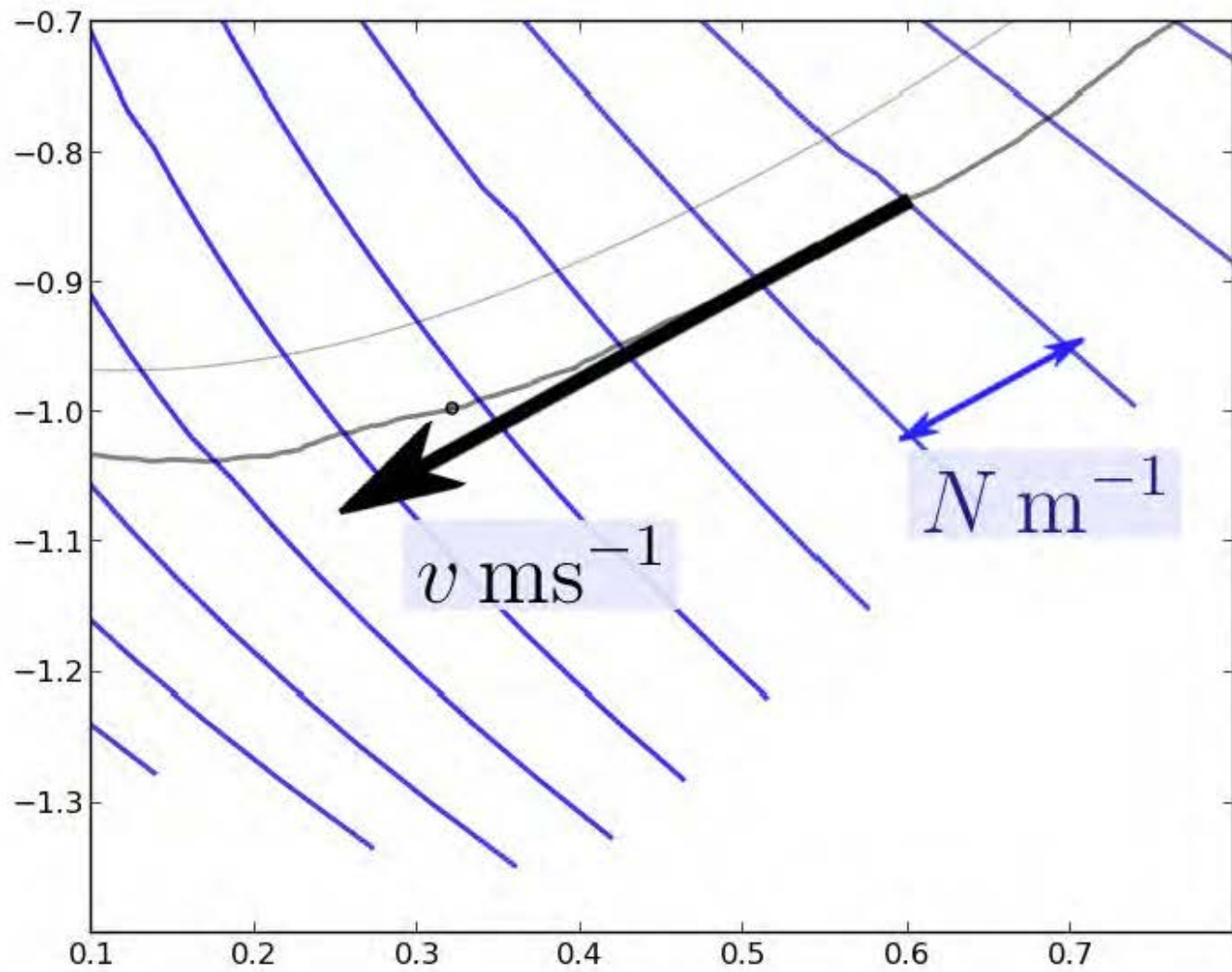


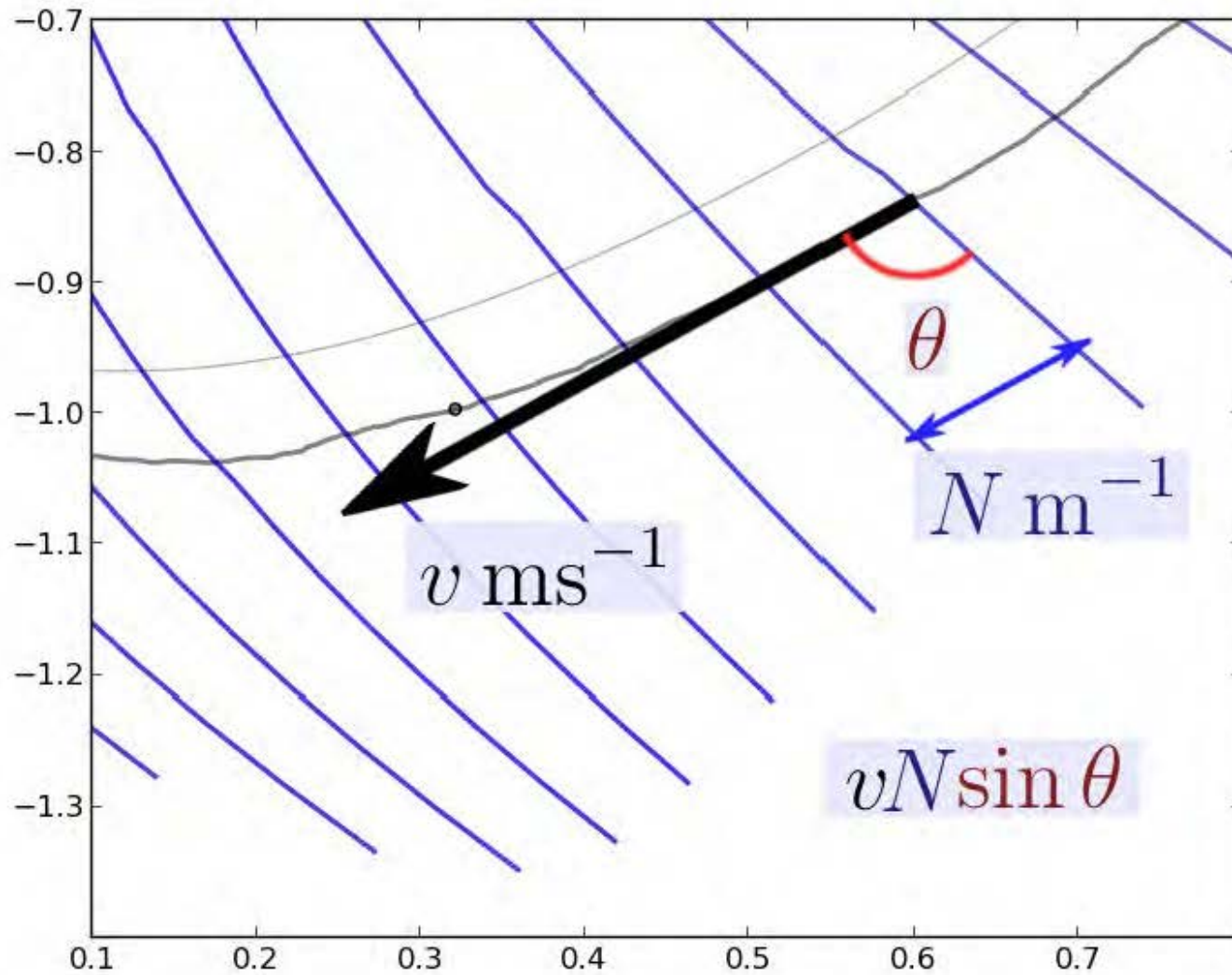




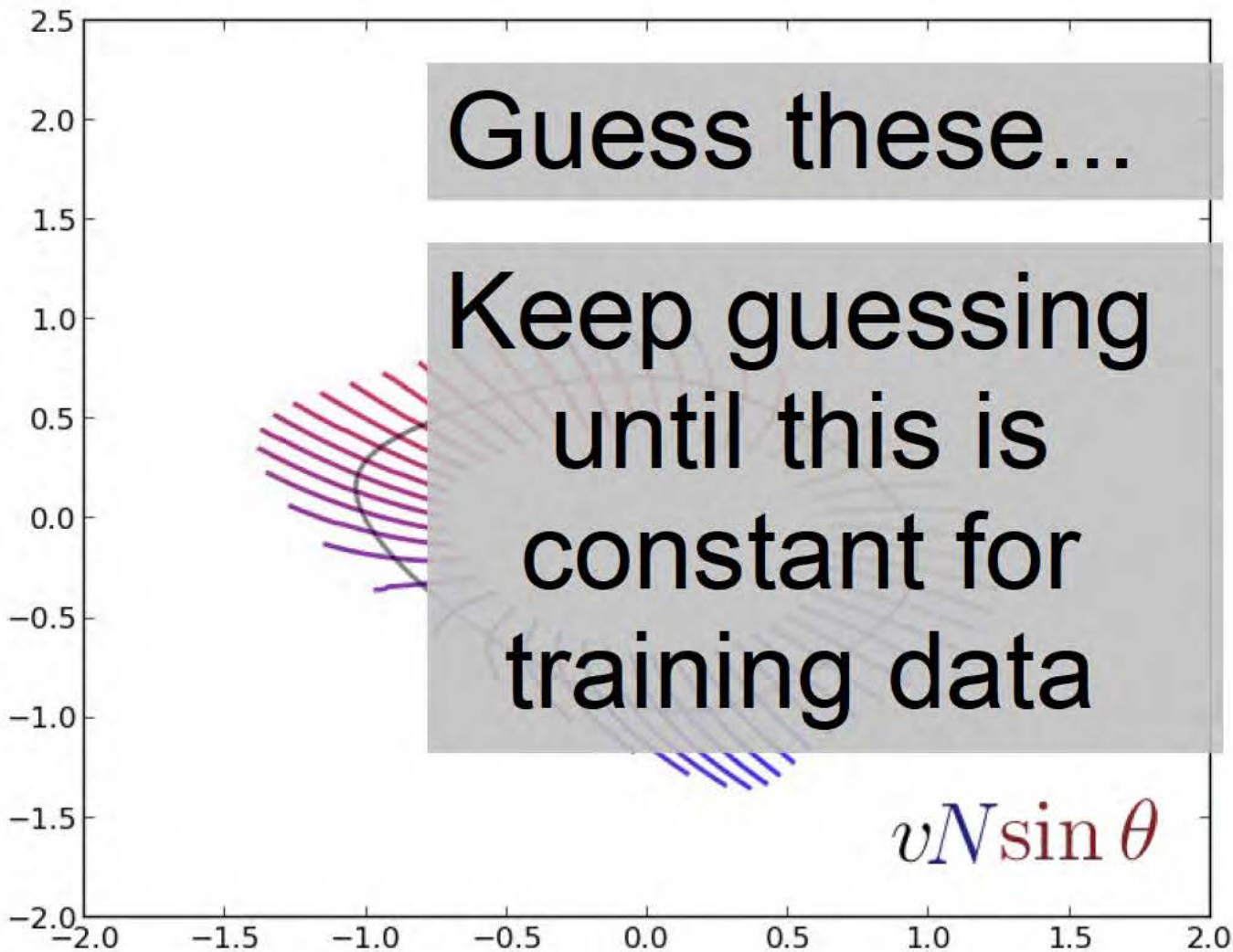


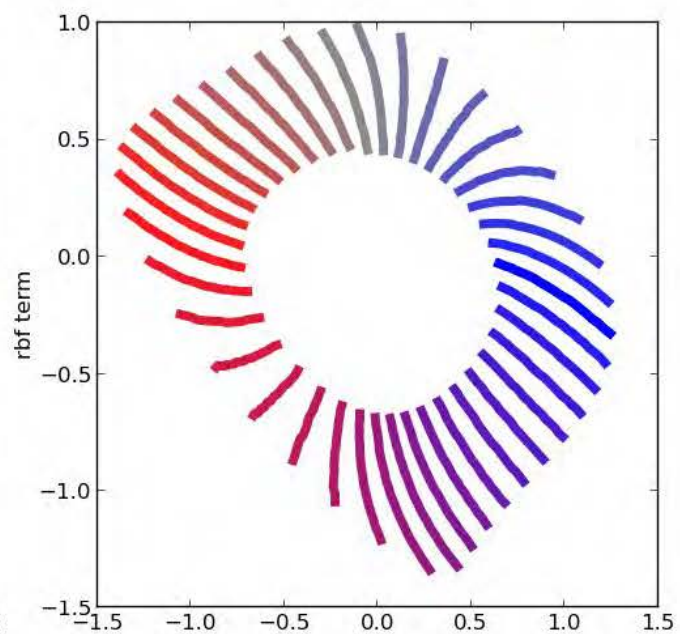
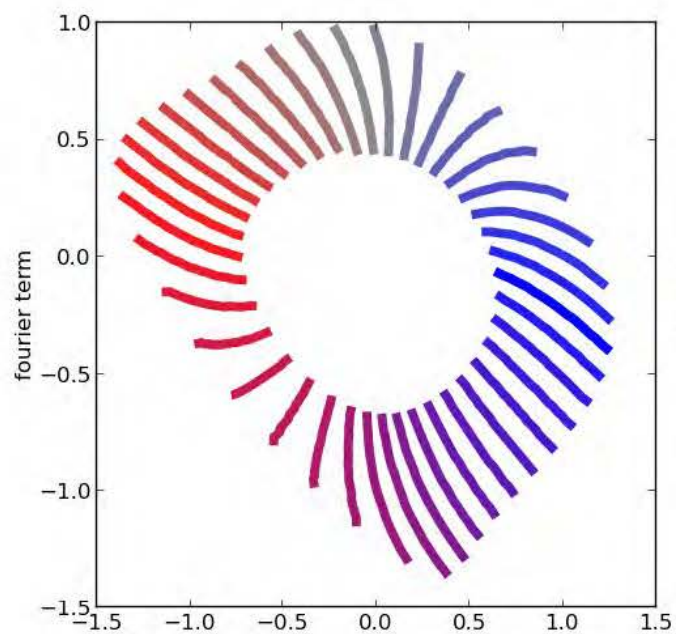
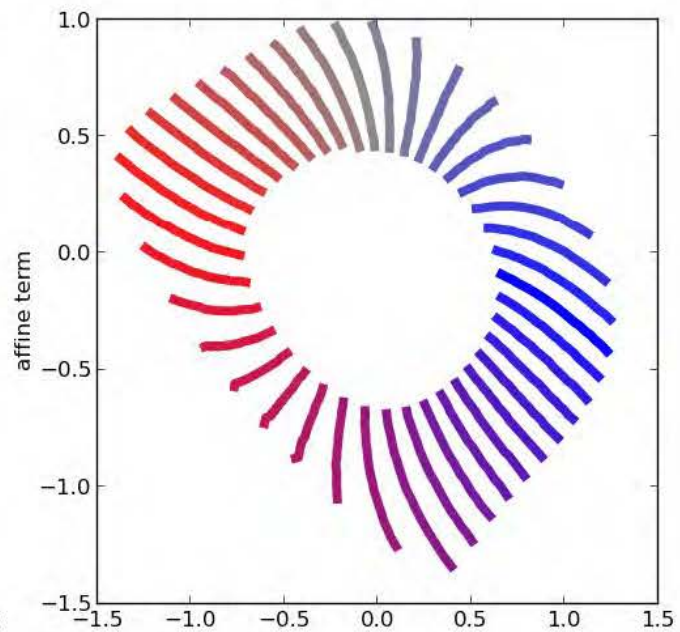
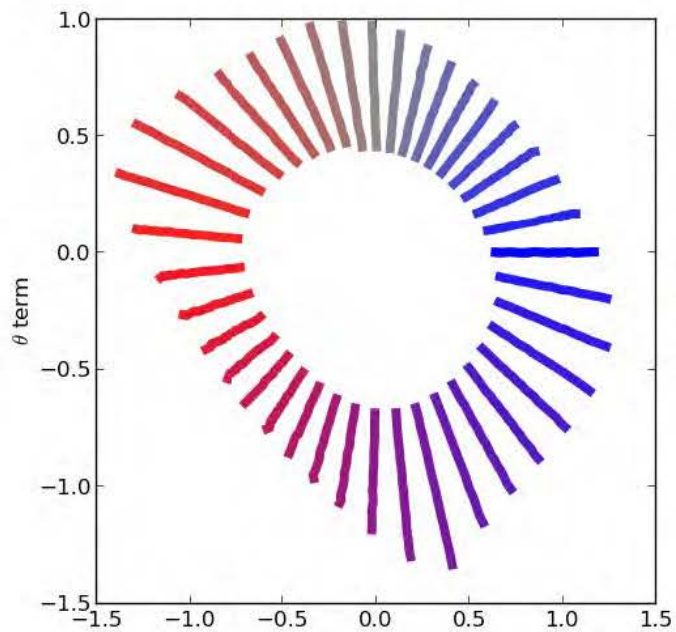


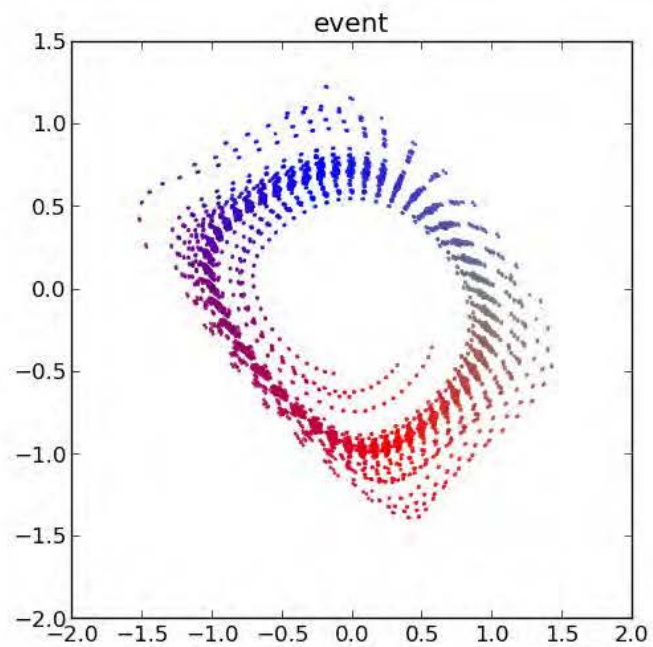
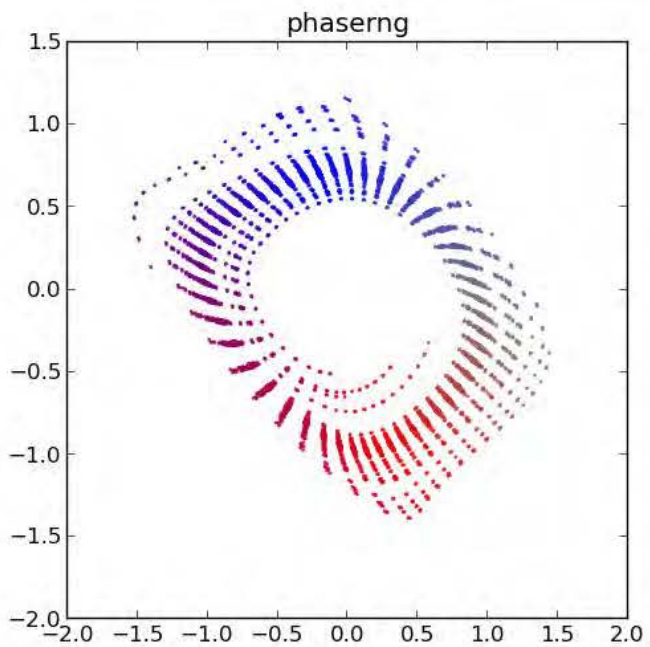
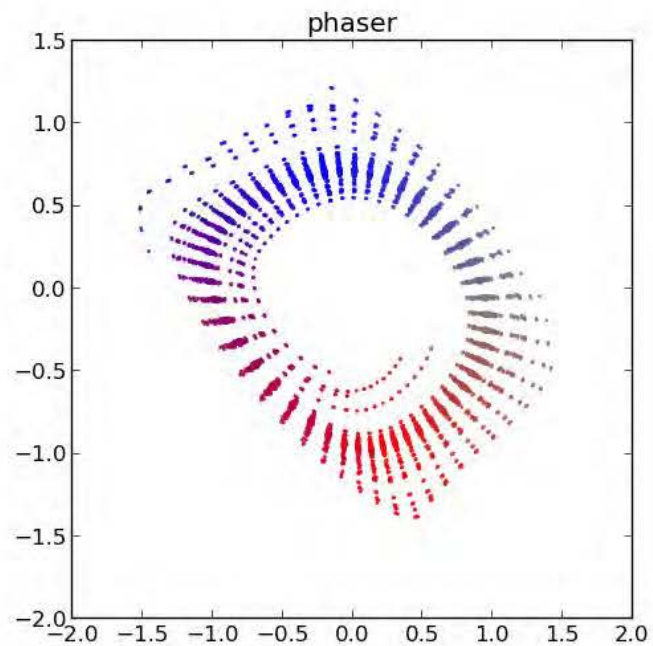
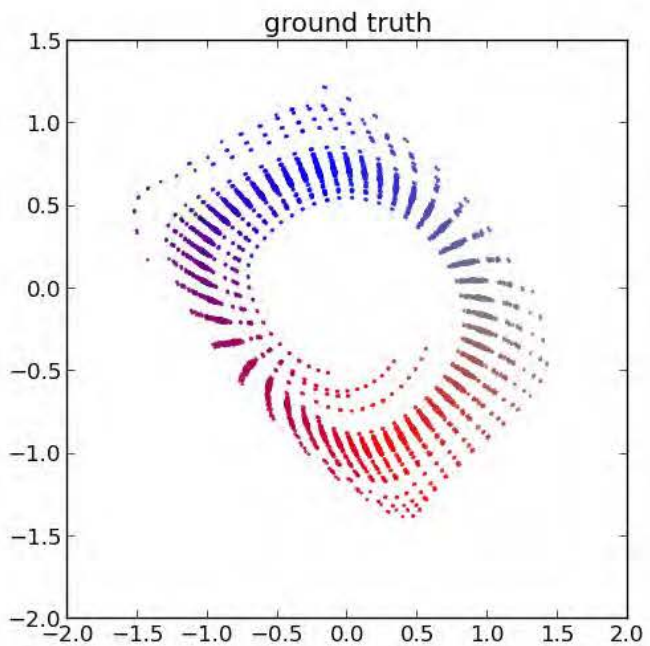


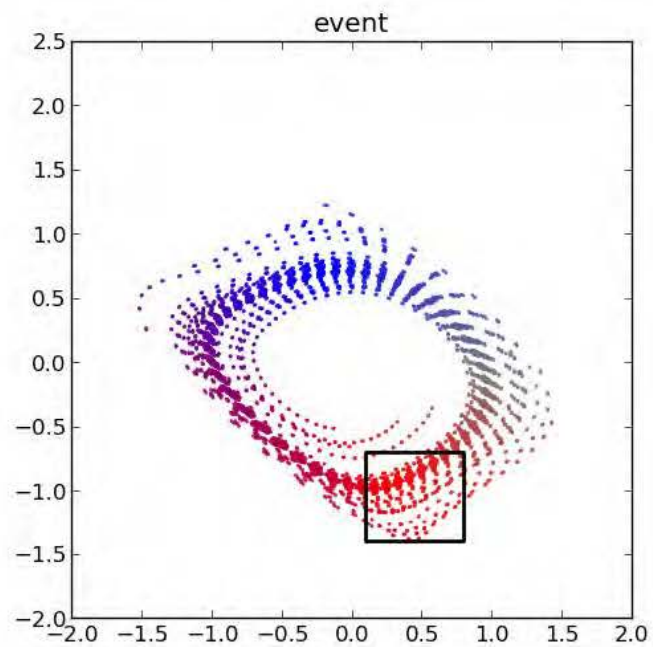
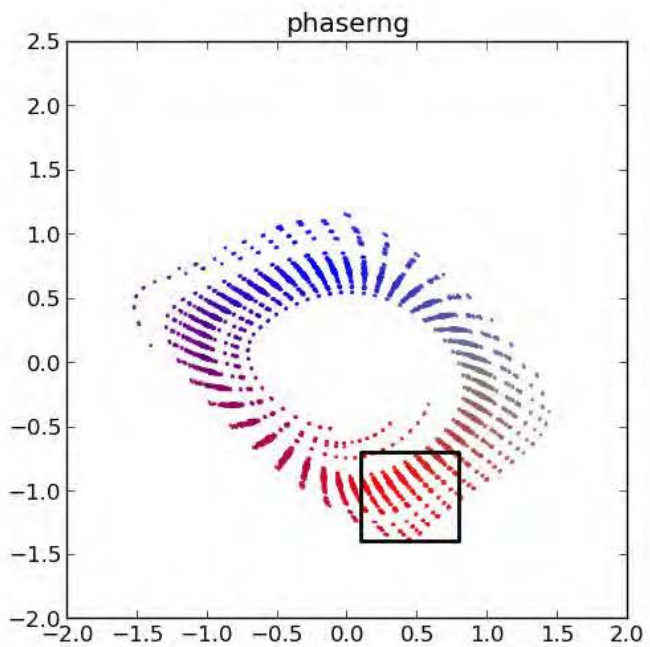
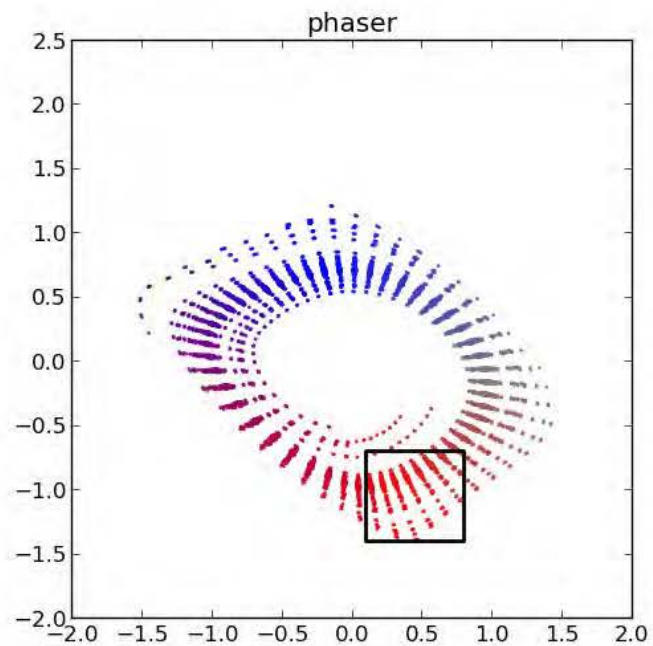
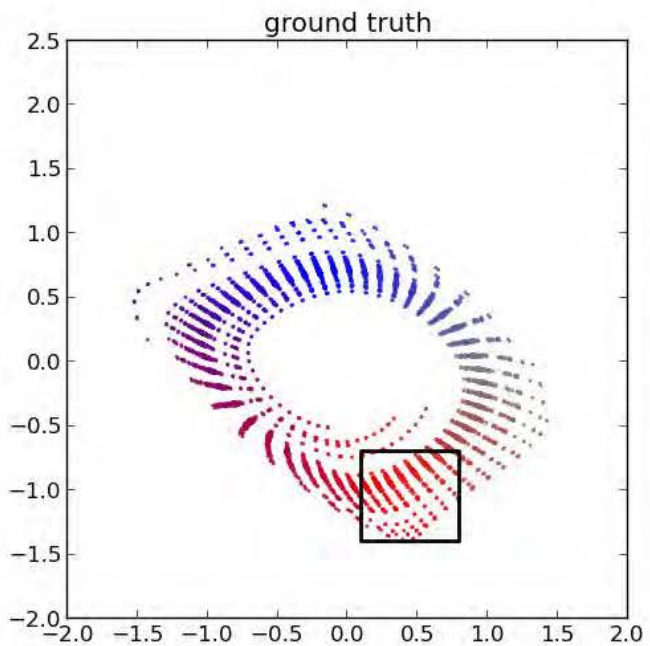


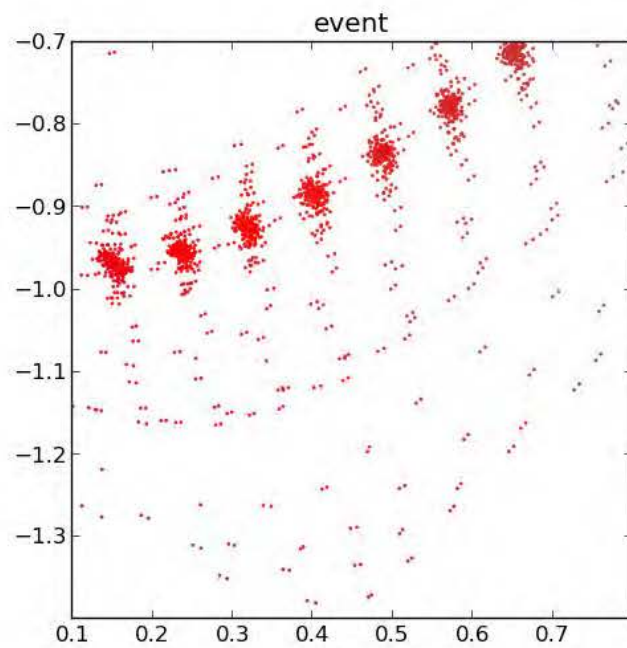
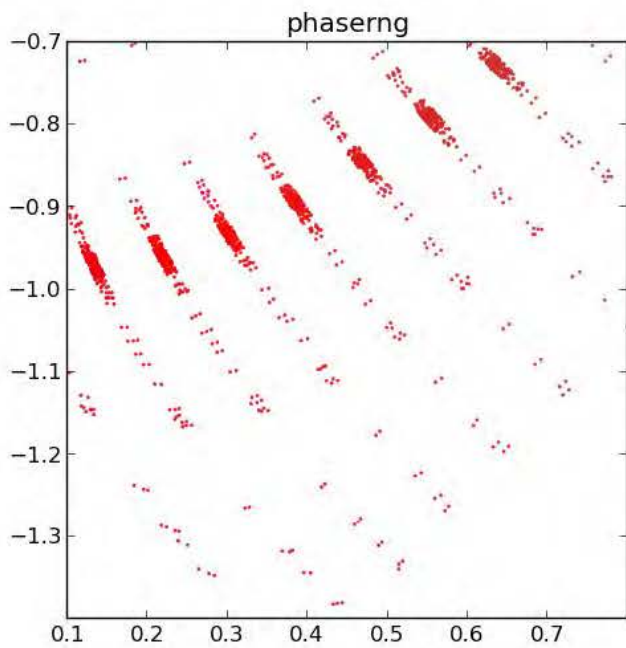
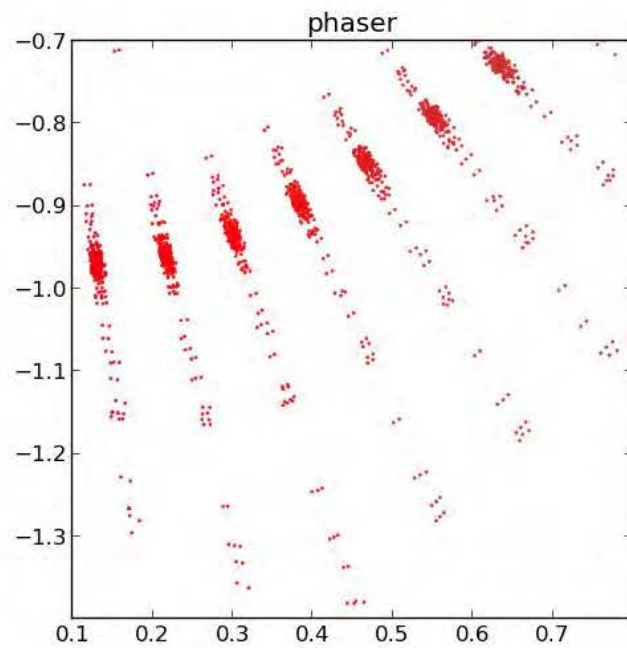
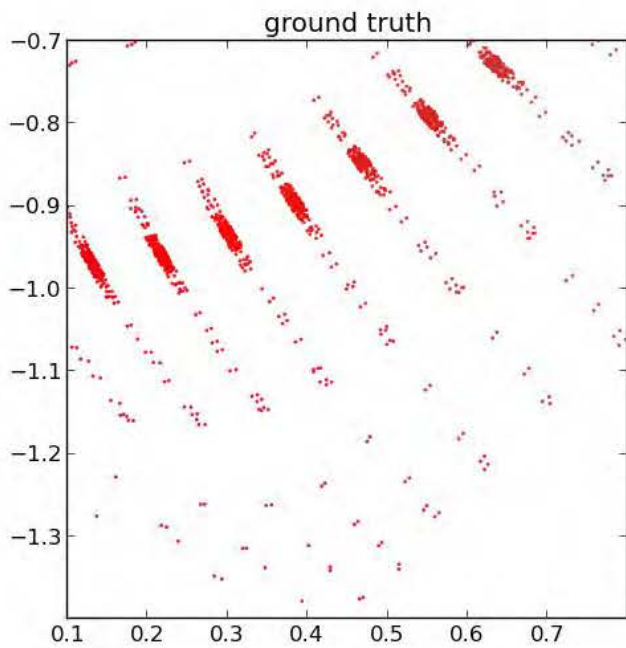
The grand plan...

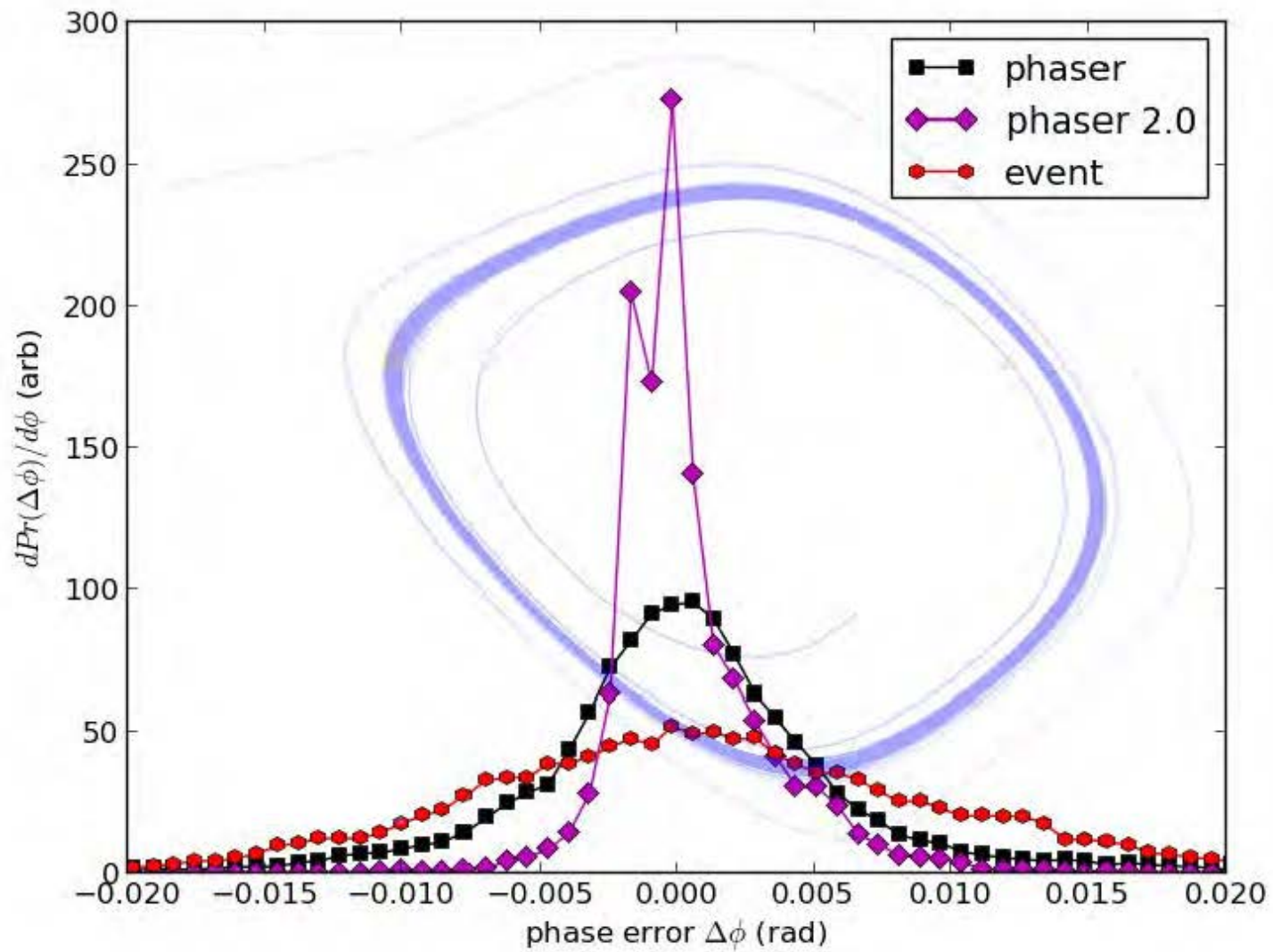


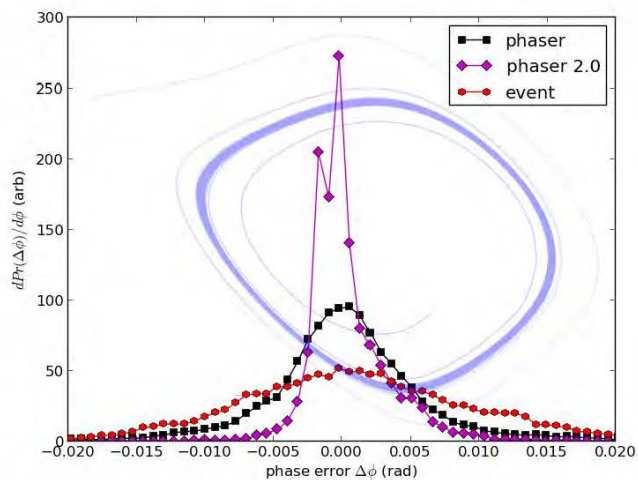
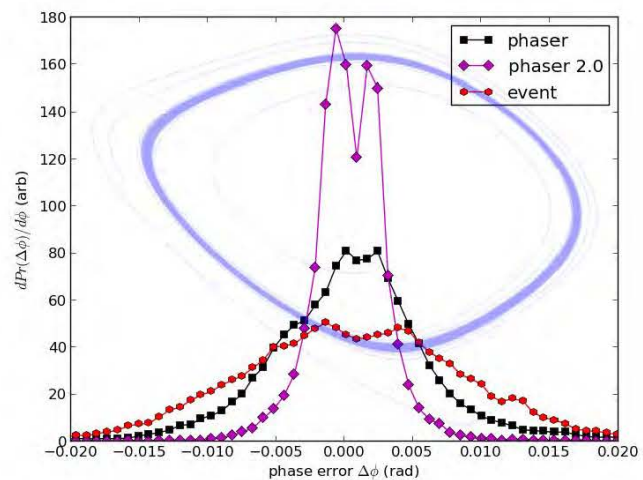
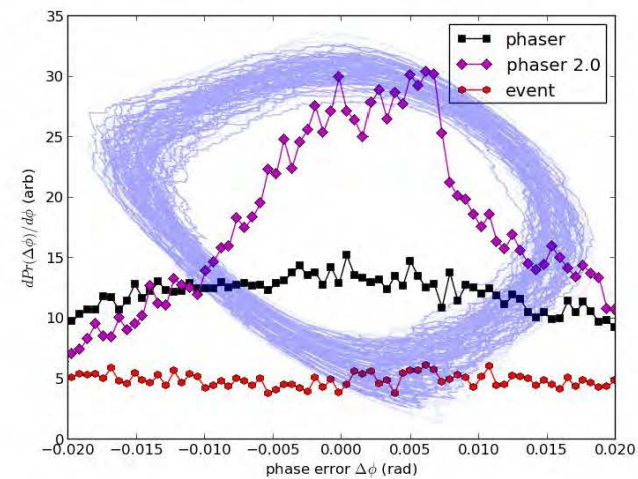
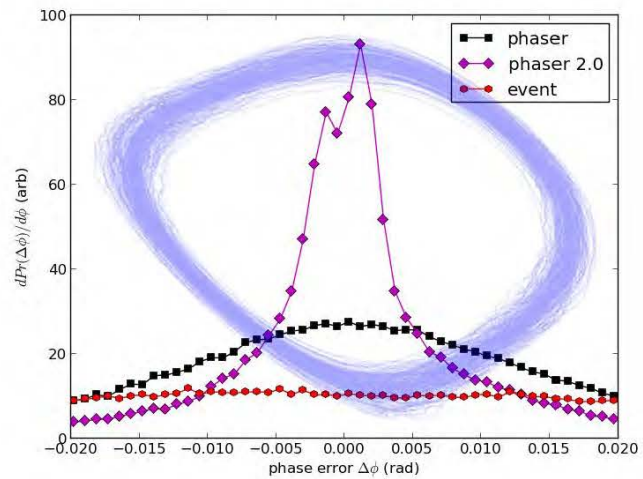
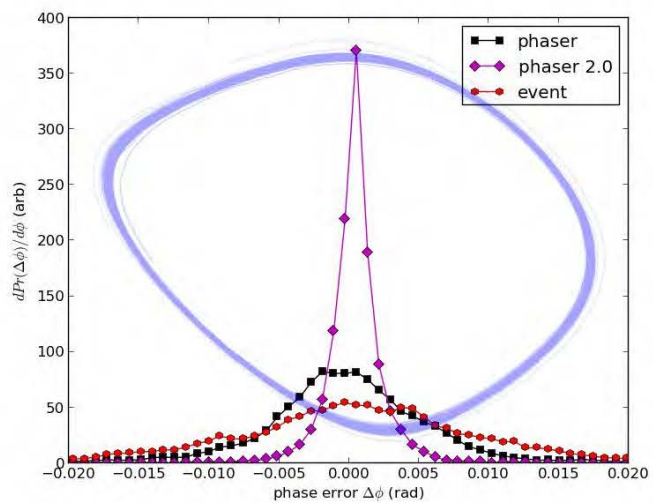


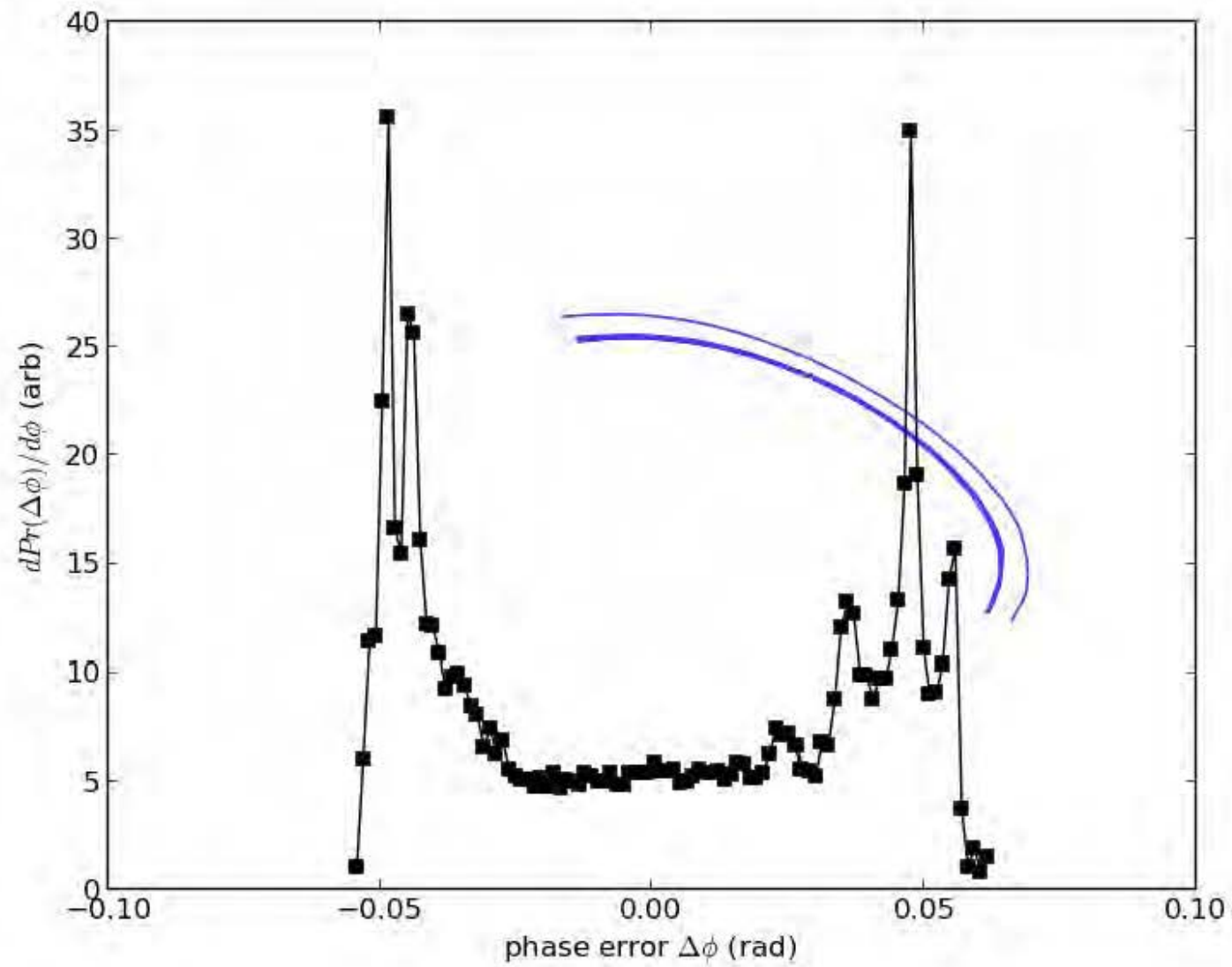












Conclusion

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Monica Daley – Royal Veterinary College

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a grant from the BBSRC



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