Joe Bentley

Email: joebentley10@gmail.com Country: Germany GitHub: joebentley Site: joebentleyphysics.com Citizenship: UK

An early career researcher, excited to further the various cutting edge projects I am working on. I am an expert in the field of reducing quantum noise for high-precision measurements, and am a pioneer in combining this with the previously unrelated field of quantum network synthesis. I also have significant programming experience, and have developed my own software to facilitate the synthesis of quantum systems directly from their transfer functions.

Research interests	Quantum network synthesis; high-precision measur tum optics, quantum optomechanics.	rements; non-linear quan-	
Employment	Universität Hamburg	Hamburg, DE	
	Postdoctoral researcher	August 2021–Present	
Education	University of Birmingham	Birmingham, UK	
	PhD focussing on Quantum noise reduction	October 2017–June 2021	
	Mentors: Dr. Haixing Miao, Professor Andreas Freise		
	MPhys in Physics	June 2013–June 2017	
	First class with honours		
Selected Publications	All-optical PT symmetric amplifier in a gravitational wave detector <i>Joe Bentley</i> , Yanbei Chen, Yiqiu Ma, Xiang Li, Denis Martynov, and Haixing Miao. <i>In preparation</i>		
	Designing Optimal Linear Detectors: A Bottom <i>Joe Bentley</i> , Hendra Nurdin, Xiang Li, Yanbei Chen, <i>Phys. Rev. Applied</i> 19 , 034009 – Published 2 March 20	- Up Approach and Haixing Miao. 223	
	Enhancing interferometer sensitivity without sacrificing bandwidth and stability: Beyond single-mode and resolved-sideband approxima- tion		
	Xiang Li, Jiri Smetana, Amit Singh Ubhi, Joe Bentle	y, Yanbei Chen, Yiqiu Ma,	
	Haixing Miao, and Denis Martynov.	-	
	Phys. Rev. D 103, 034009 – Published 10 June 2021		
	Direct approach to realizing quantum filters for high-precision mea- surements		
	Joe Bentley, Hendra Nurdin, Yanbei Chen, and Haixi	ng Miao.	

Phys. Rev. A 103, 013707 – Published 7 January 2021

A Broadband Signal Recycling Scheme for Approaching the Quantum Limit from Optical Losses

Teng Zhang, Joe Bentley, and Haixing Miao. Galaxies 2021, 9(1), 3 – Published 1 January 2021

Towards observing the neutron star collapse with gravitational wave detectors

Teng Zhang, George Smetana, Yikang Chen, *Joe Bentley*, William E. East, Denis Martynov, Haixing Miao, and Huan Yang. *arXiv:2011.06705* [gr-qc] – *Submitted 13 November 2020*

Converting the signal-recycling cavity into an unstable optomechanical filter to enhance the detection bandwidth of gravitational-wave detectors

Joe Bentley, Philip Jones, Denis Martynov, Andreas Freise, and Haixing Miao. Phys. Rev. D 99, 102001 – Published 14 May 2019

Research projects An all-optical PT symmetric quantum amplifier

Previously by Xiang Li et.al. it was shown that a stable detector that surpasses the often-cited "Mizuno limit" can be produced by coupling two modes to the readout mode via a PT (parity-time) symmetric interaction. This setup utilised a mechanically suspended mirror to facilitate this interaction, and thus suffered greatly from thermal noise. Therefore we are now in the process of designing an all-optical setup that uses a non-linear crystal and thus does not suffer from thermal noise.

Designing the Optimal Detector 2019–Present

Until now, the design of new detectors for high-precision measurement has been almost entirely by a priori knowledge and intuition. However using novel ideas from quantum network synthesis and PT (parity-time) symmetric systems, for the first time we can systematically develop detectors with optimal sensitivity that achieves the Heisenberg limit, while also having a constraint on the complexity of the resulting setup.

Simba Source – Documentation 2019–Present Since we now have a systematic approach to creating quantum systems from their transfer matrices, I designed and developed an ongoing Python software project to systematise this process. For example, given just the frequencydomain behaviour of the system a schematic diagram can be automatically created showing how various optical or mechanical components should be coupled to reproduce that behaviour.

	Negative dispersion via Parametric Instability Towards the end of 2019 I spent 6 weeks at the University of Wester working at their Gingin site. While there I had some significant h perience with the optics and electronics, while also supporting th nificant theoretical guidance on an experiment to observe negative via parametric instability.	Fall 2019 ern Australia nands-on ex- em with sig- re dispersion
	Transmission-readout setup My first major PhD project was an unstable version of the PT syn plifier mentioned above, in the case where there is no PT symme volved significant preliminary research in quantum optics, learnin field as well as the quantum noise formalism, and culminated in m published in 2019.	2017–2019 mmetric am- etry. This in- ng the wider ny first paper
Teaching experience	First year labs (University of Birmingham) 2017–2019 Experimental labs for first year undergraduate students. This involved learning an experiment in depth, grading weekly reports, and giving detailed and ap- propriate feedback. I learnt a lot about how to give appropriate and in-depth feedback for each student, as well as skills to improve my own reports and papers.	
	Second year computing labs (University of Birmingham) Computing labs using the programming language Python for second ergraduate students. Mostly this was focused on numerical simulations as rocketry simulations. Being a high-pressure environment with dents and few teaching staff, it taught me how to manage a large students and judge who needs the most help.	2017–2018 ond year un- ilations such h many stu- re number of
Talks	All-optical realization of PT symmetric amplifier – Link MQM telecon January 2021	
	Finding the optimal detector – Link LVK September 2020 held virtually	
	A systematic approach to the realization of quantum optical Link Gravitational Wave Advanced Detector Workshop May (GWAD Elba	ll systems – DW) 2019 in
	Unstable Filter Update: Thermal Noise and Controllability Sept 2018 LSC-Virgo Collaboration Meeting in Maastricht	– Link
	Reducing the Shot Noise of Cosmic Explorer using an Un tomechanical Filter – Link	nstable Op-

	LVC March 2018 at Sonoma State University
Skills	Programming Proficient in: Python, Mathematica, C++, Javascript, HTML/CSS. Familiar with: Matlab, Ruby, C, Rust, Haskell.
	Languages English (fluent), German (basic-intermediate), French (basic)
Other interests	I have a strong interest in music and music production, and have released my own short album as well as a few EPs. I was also in a band for my under- graduate years with some old school friends, which helped bring a sense of responsibility and gave me a lot of confidence. Also, I am very motivated and curious to learn new programming languages, as I greatly enjoy the learning process and also building things. Finally, I am interested in visual design and especially using 3D graphics libraries such as three.js.