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Publishing executable papers

Matthias Troyer and Jan Gukelberger (ETH Zurich)
Michael H. Freedman (Microsoft)

with help from the VisTrails team,
especially David Koop, Emanuele Santos, and Juliana Freire

PHYSICAL REVIEW B **85**, 045414 (2012)

Galois conjugates of topological phases

M. H. Freedman,[1] J. Gukelberger,[2] M. B. Hastings,[1] S. Trebst,[1] M. Troyer,[2] and Z. Wang[1]
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Numerical experiments + theorem and proof

- Can we build quantum computers based on non-unitary conformal field theories?
- First reproducible numerical experiment, then theorem and proof.

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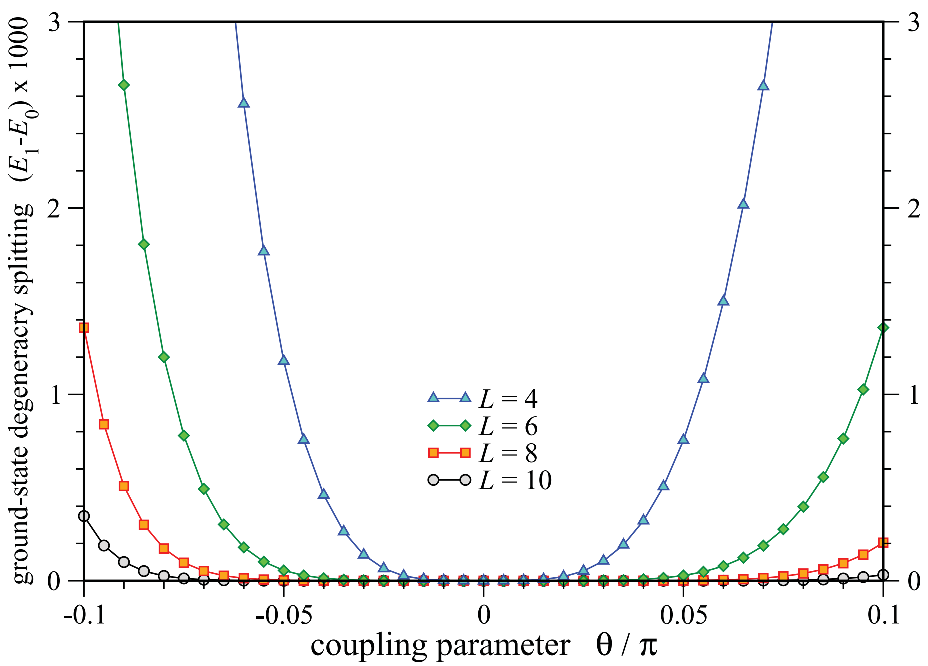

FIG. 6. (Color online) Ground-state degeneracy splitting of the non-Hermitian doubled Yang-Lee model when perturbed by a string tension ($\theta \neq 0$). This figure can be reproduced using the VisTrails[33] workflow Fig. 6 included in the Supplementary Material.[37]

Theorem IV.5. Fixing the number $n \geqslant 5$ and particle type $\tau \otimes \tau$ of DFib anyons on S^2 and any vertex normalization f, there can be no continuous uniform Γ family of (g.s. weakly) local normalizer operators O_Γ: $\mathcal{H} \rightarrow \mathcal{H}$, so that $\mathcal{O}_\Gamma G^{\mathcal{G}}_{n,\Gamma,f}$ is, for all anyon positions Γ, the ground-state manifold of a uniformly Lieb-Robinson and uniformly gapped family of Hermitian Hamiltonians $H(\Gamma)$ defining a topological phase [see Eq. (1)].

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Galois Conjugates of Topological Phases

Michael H. Freedman, Jan Gukelberger, Matthew B. Hastings, Simon Trebst, Matthias Troyer, Zhenghan Wang

(Submitted on 16 Jun 2011 (v1), last revised 5 Jul 2011 (this version, v3))

Galois conjugation relates unitary conformal field theories (CFTs) and topological quantum field theories (TQFTs) to their non-unitary counterparts. Here we investigate Galois conjugates of quantum double models, such as the Levin-Wen model. While these Galois conjugated Hamiltonians are typically non-Hermitian, we find that their ground state wave functions still obey a generalized version of the usual code property (local operators do not act on the ground state manifold) and hence enjoy a generalized topological protection. The key question addressed in this paper is whether such non-unitary topological phases can also appear as the ground states of Hermitian Hamiltonians. Specific attempts at constructing Hermitian Hamiltonians with these ground states lead to a loss of the code property and topological protection of the degenerate ground states. Beyond this we rigorously prove that no local change of basis can transform the ground states of the Galois conjugated doubled Fibonacci theory into the ground states of a topological model whose Hermitian Hamiltonian satisfies Lieb-Robinson bounds. These include all gapped local or quasi-local Hamiltonians. A similar statement holds for many other non-unitary TQFTs. One consequence is that the "Gaffnian" wave function cannot be the ground state of a gapped fractional quantum Hall state.

Comments:	16 pages, 8 figures
Subjects:	**Strongly Correlated Electrons (cond-mat.str-el)**; Mesoscale and Nanoscale Physics (cond-mat.mes-hall); Mathematical Physics (math-ph)
Journal reference:	Phys. Rev. B 85, 045414 (2012)
DOI:	10.1103/PhysRevB.85.045414
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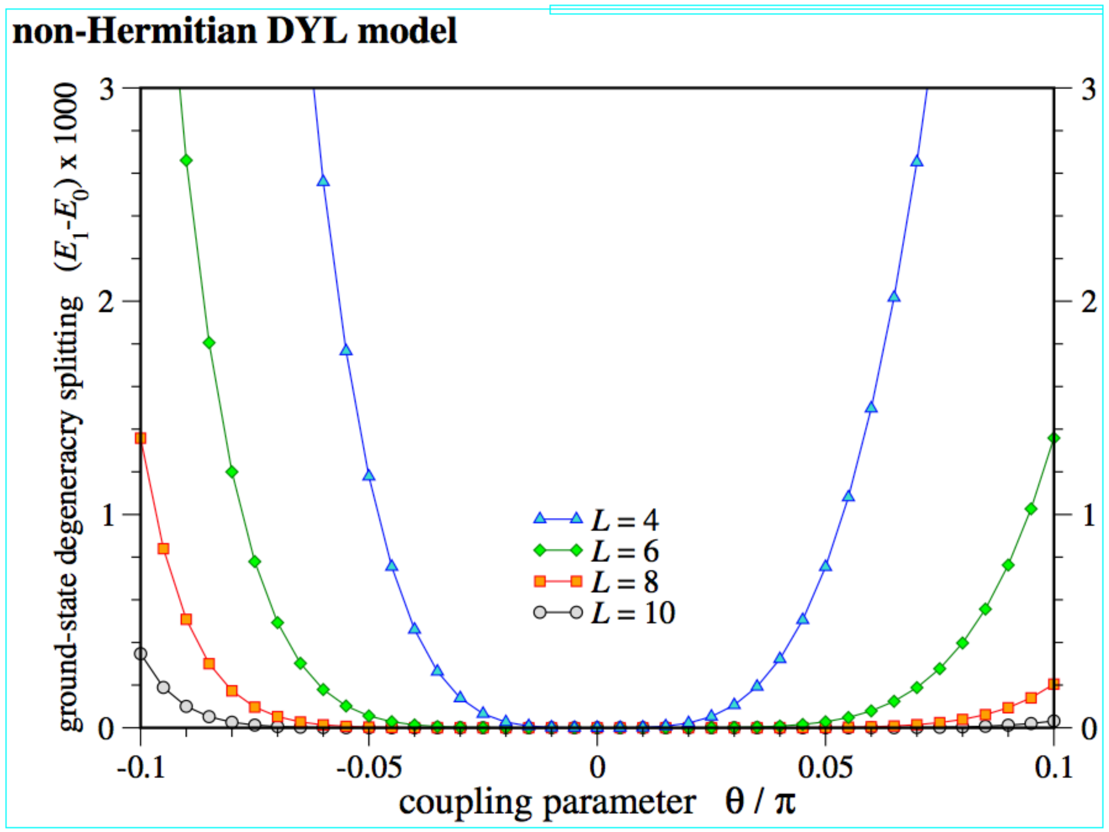

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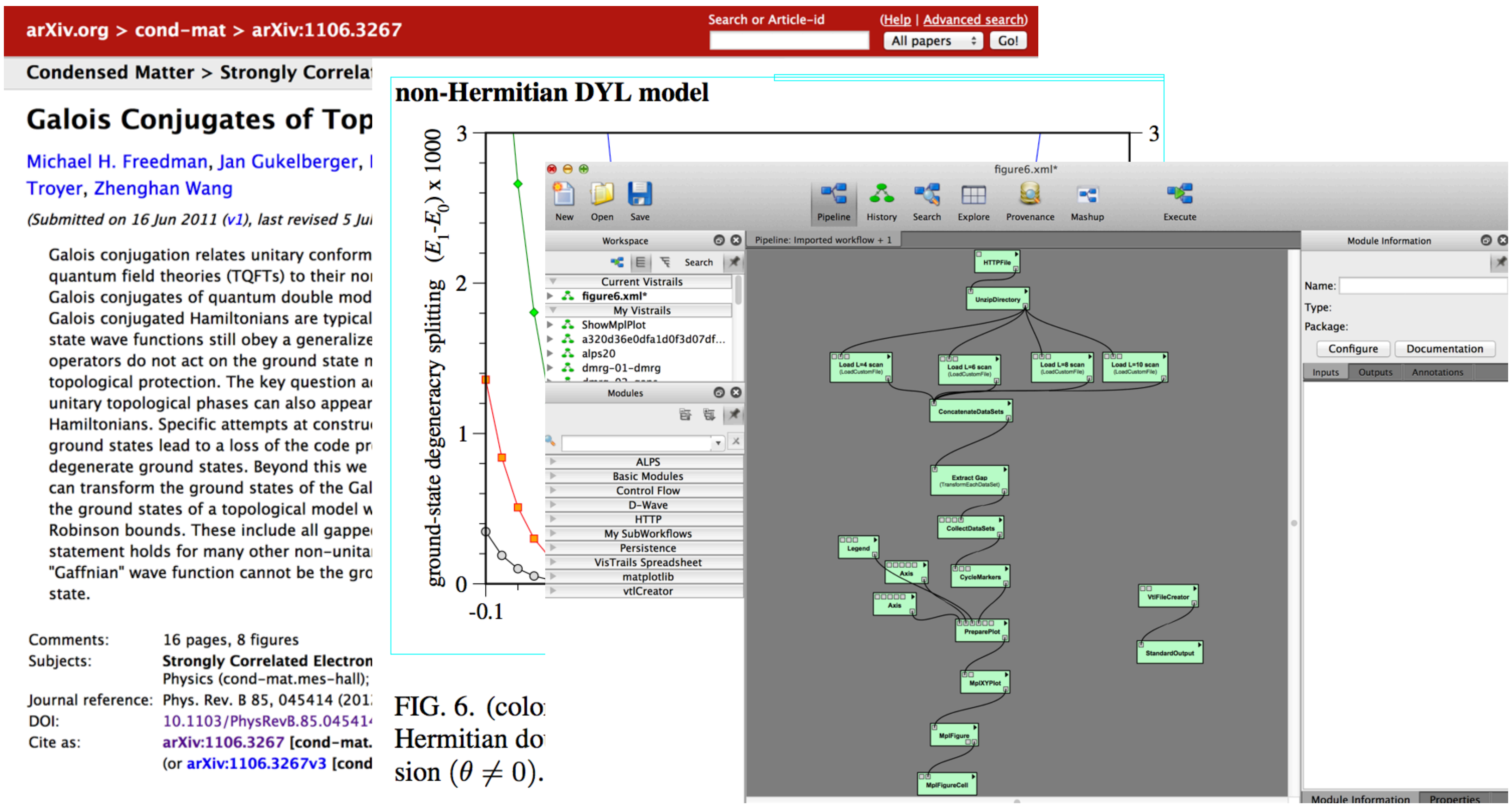

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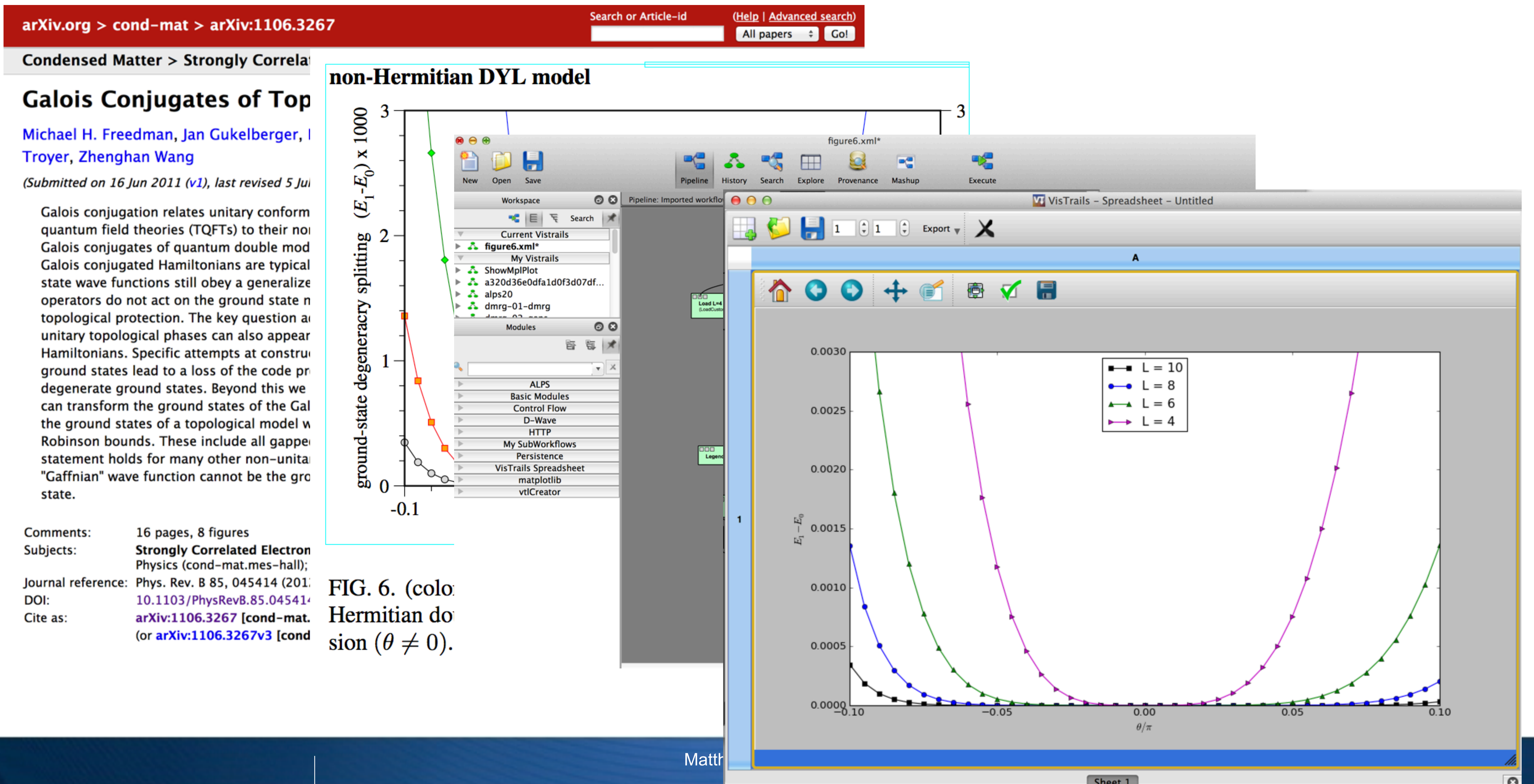

Publishers were excited!

- This is how it should be!
- Start a trial project to see how it can be made to work!

Publishers were excited!

- This is how it should be!
- Start a trial project to see how it can be made to work!

- But they soon gave up ....

Publishing requires compromises (1)

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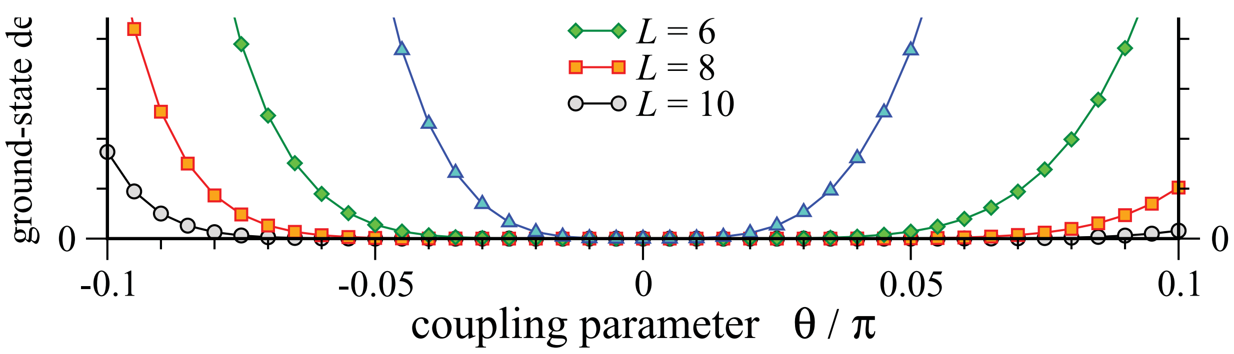

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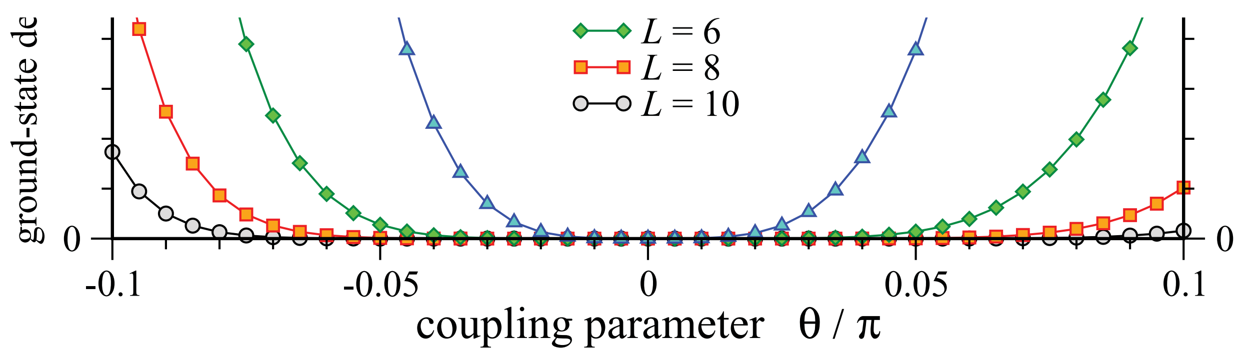

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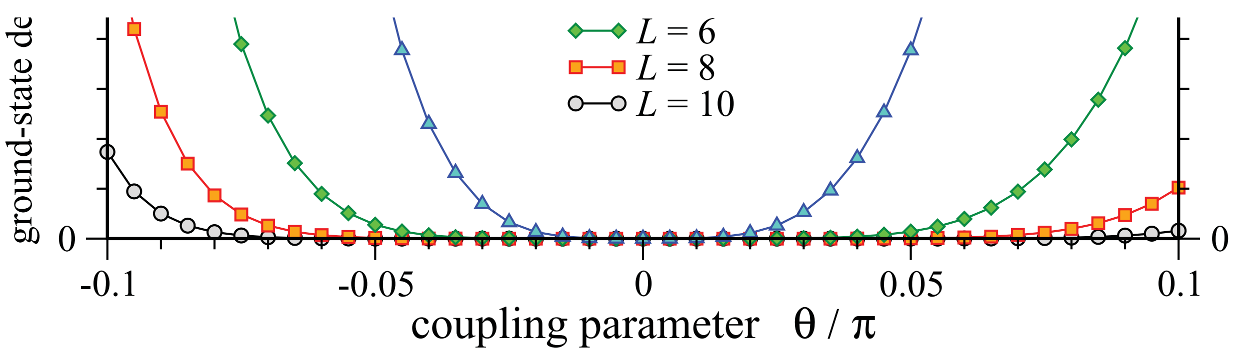

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Galois conjugates of topological phases

Abstract | References | Citing Articles (2) | **Supplemental Material**

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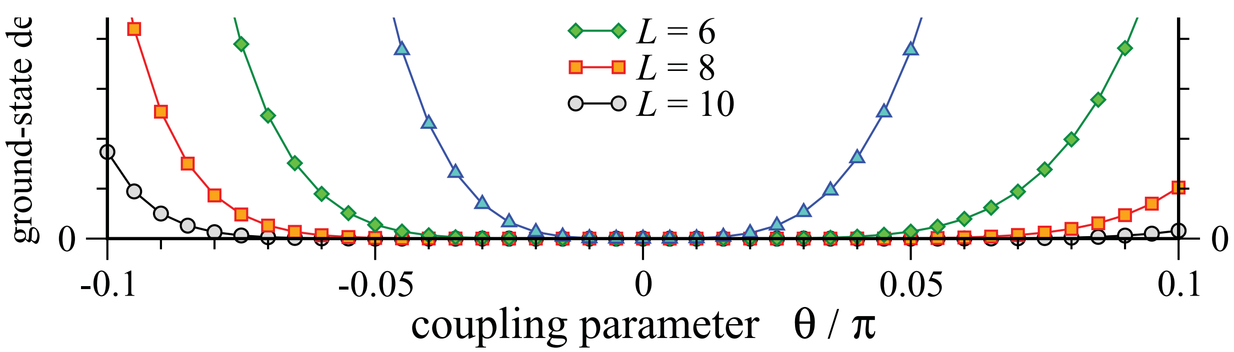

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- Physical Review, an APS journal
  - Editors told us to give up
  - Production manager informed us that we can replace the supplementary material anytime after publication without leaving a trace ....
  - We then just sent the working workflows with the right URLs for data after publication

Our next approach

- Publishers desire reproducible papers but are not yet ready to handle executable papers in the publication process

- Our intermediate solution:
  - Publish raw data and workflows through our institutional library and obtain DOIs
  - Refer to that data from the paper and just include a backup copy with the papers