

Title: Towards constraining realistic Lorentzian wormholes through observations

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Ever since their revival, three decades ago, in the seminal work of Morris and Thorne, Lorentzian wormholes in General Relativity have led an uncomfortable existence because they require matter which violates the well-known energy conditions. However, in scalar-tensor and other theories of gravity realistic wormholes can indeed exist with ‘normal matter’. We illustrate this with some known examples and also by explicitly constructing a zero Ricci scalar wormhole in a four dimensional scalar-tensor, on-brane gravity theory arising from the two-brane Randall-Sundrum model with one extra dimension. If such a wormhole could arise as the end-state of some astrophysical process, its ringdown may be studied using gravitational waves. With this aim, we obtain the scalar quasinormal modes in this class of wormholes and choose to identify them as for the ‘breathing mode’ associated with gravitational waves in scalar-tensor theories. Finally, with the frequencies, time constants of the breathing mode as well as results arising out of GW150914, we estimate the errors in the wormhole parameters using standard tools. Our analysis suggests that it may be possible to constrain wormholes and distinguish them from black holes in this way. If in future observations we are able to confirm the existence of such wormholes, we would, at one go, have some indirect evidence of a modified theory of gravity as well as extra spatial dimensions.

References:

1. S. Kar, S. Lahiri and S. Sengupta, Phys. Letts. **B 750**, 319 (2015).
2. R. Shaikh and S. Kar, Phys. Rev. **D 94**, 024011 (2016).
3. S. Aneesh, S. Bose and S. Kar, arxiv:1803.10204.