WHEN DO KOOPMAN EMBEDDINGS EXIST? A USER'S GUIDE

MATTHEW D. KVALHEIM

ABSTRACT. The following list gives precise references to those results relevant to existence of continuous (or smoother) one-to-one linearizing maps from my presentation "When do Koopman embeddings exist?" at the workshop "Koopman Operator Theory: Fundamentals, Approximations, and Applications 2" delivered at Moise Palace in Cres, Croatia on Friday, September 12, 2025.

- Slide 3: Corollary 33 and Proposition 38 of [Mez21].
- Slide 6: Theorems 2.3, 2.5 and 2.6 and Remark on p. 47 of [LM13]; Propositions 2 and 3 of [KR21].
- Slide 7: Theorem 2 of [KS25].
- Slide 8: the first proposition is Proposition 1 of [KS25]. The second proposition is Theorem 10 of [Kva25]. The theorem is Theorem 1 of [Kva25].
- Slide 10: the first bulleted result is Corollary 6 of [KA24]. The second bulleted result is Corollary 3 of both [LOS23] and [LOS25].
- Slide 12: Theorem 1 of [AK23]. Footnote: [CFI83, Bel22a, Bel22b, BC23, KB24, KB25, HB25].
- Slide 13: Figure 1 of [AK23].
- Slide 15: Corollary 33 and Proposition 38 of [Mez21].
- Slide 18: Theorem 3 combined with Remark 3 of [KA24].
- Slide 20: Example 7 of [KA24].
- Slide 21: the theorem is a partial statement of Theorem 4 in [KA24].
- Slide 22: the theorem is a combination of Theorems 1 and 2 in [KA24].
- Slide 23: Figure 1 of [KA24].
- Slide 24: Corollaries 1 and 2 of [KA24].
- Slide 25: Proposition 1 of [KS25].

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REFERENCES

- [AK23] P Arathoon and M D Kvalheim, Koopman embedding and super-linearization counterexamples with isolated equilibria, arXiv preprint arXiv:2306.15126 (2023), 1–7.
- [BC23] M-A Belabbas and X Chen, A sufficient condition for the super-linearization of polynomial systems, Systems Control Lett. 179 (2023), Paper No. 105588, 6. MR 4624015
- [Bel22a] M-A Belabbas, Canonical forms for polynomial systems with balanced superlinearizations, arXiv preprint arXiv:2212.12054 (2022).
- [Bel22b] ______, Visible and hidden observables in super-linearization, arXiv preprint arXiv:2211.02739 (2022).

- [CFI83] D Claude, M Fliess, and A Isidori, Immersion, directe et par bouclage, d'un système non linéaire dans un linéaire, C. R. Acad. Sci. Paris Sér. I Math. 296 (1983), no. 4, 237–240. MR 692986
- [HB25] A Harshana and M-A Belabbas, On the invariance of super-linearization under polynomial automorphisms, arXiv preprint arXiv:2503.13849 (2025).
- [KA24] M D Kvalheim and P Arathoon, Linearizability of flows by embeddings, arXiv preprint arXiv:2305.18288v6 (2024), 1–20.
- [KB24] J Ko and M-A Belabbas, Minimum number of observables and system invariants in super-linearization, IEEE Control Systems Letters (2024).
- [KB25] _____, Super-linearization with monomial observables: Necessary and sufficient conditions, IFAC-PapersOnLine 59 (2025), no. 4, 127–132.
- [KR21] M D Kvalheim and S Revzen, Existence and uniqueness of global Koopman eigenfunctions for stable fixed points and periodic orbits, Phys. D 425 (2021), Paper No. 132959, 20. MR 4275046
- [KS25] M D Kvalheim and E D Sontag, Global linearization without hyperbolicity, arXiv preprint arXiv:2502.07708 (2025).
- [Kva25] M D Kvalheim, Differential topology of the spaces of asymptotically stable vector fields and Lyapunov functions, arXiv preprint arXiv:2503.10828 (2025).
- [LM13] Y Lan and I Mezić, Linearization in the large of nonlinear systems and Koopman operator spectrum, Phys. D 242 (2013), 42–53. MR 3001394
- [LOS23] Z Liu, N Ozay, and E D Sontag, On the non-existence of immersions for systems with multiple omega-limit sets, IFAC World Congress, Yokohoma, Japan (2023).
- [LOS25] ______, Properties of immersions for systems with multiple limit sets with implications to learning Koopman embeddings, Automatica 176 (2025), 112226.
- [Mez21] I Mezić, Koopman operator, geometry, and learning of dynamical systems, Notices Amer. Math. Soc. 68 (2021), no. 7, 1087–1105. MR 4295666