The boundary of moduli spaces: between algebras and geometry

Veronica Collazuol

IPhT CEA/Saclay

Based on

- Work in progress with S. Baines, B. Fraiman, M. Graña and D. Waldram
- arXiv:2203.01341, arXiv:2210.13471 with M. Graña, A. Herraez and H. Parra De Freitas
- arXiv:2402.01606 with I. V. Melnikov

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Motivation: the Distance Conjecture

From string compactifications: universal patterns appearing at infinite distance in moduli spaces.

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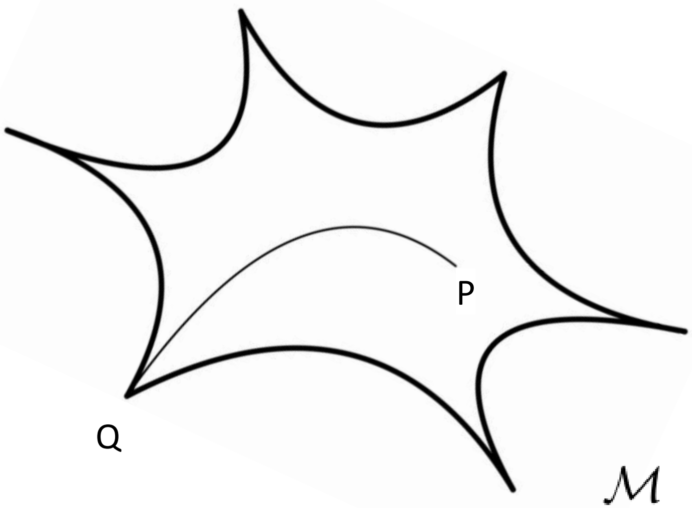
[Ooguri, Vafa, '06]



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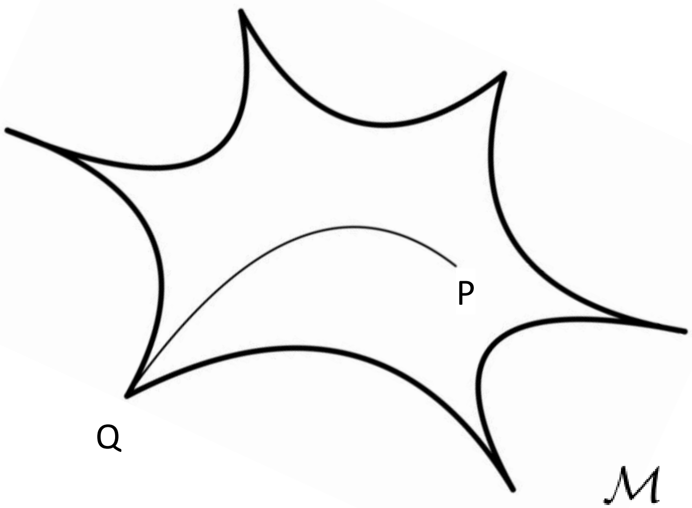

[Baume, Blumenhagen, Buratti, Calderon-Infante, Castellano, Cecotti, Corvilain, Cribiori, Etheredge, Font, Gendler, Grimm, Heidenreich, Herraez, Ibañez, Joshi, Kaya, Klaewer, Lee, Lerche, Li, Lockhart, Lust, McNamara, Marchesano, Martucci, Montella, Montero, Ooguri, Palti, Perlmutter, Qiu, Rastelli, Rudelius, Ruiz, Stout, Uranga, Vafa, Valenzuela, van de Heisteeg, Weigand, Wiesner, Wolf, …]

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Geometry of moduli spaces ⟷ **Spectrum** of the theory

- Geodesics
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- M theory on T^d: $G = E_{d(d)}$
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[Link, '08]

Definition

- **Geometric**: manifold $\mathcal{M}$ with an inversion symmetry at any point p

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We will focus on symmetric spaces of **non-compact** type.

↘ Explicit parametrization of the boundaries

- Geodesics
- Parabolic subgroups

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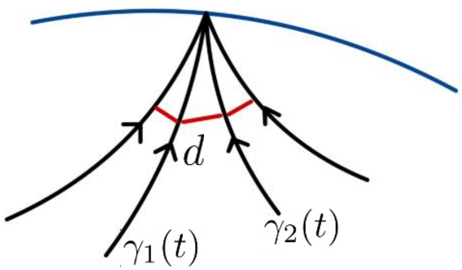

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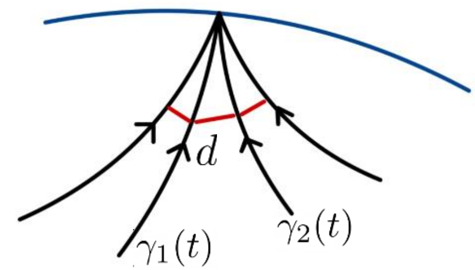

Eg. $\quad \dfrac{SL(2,\mathbb{R})}{SO(2)}$

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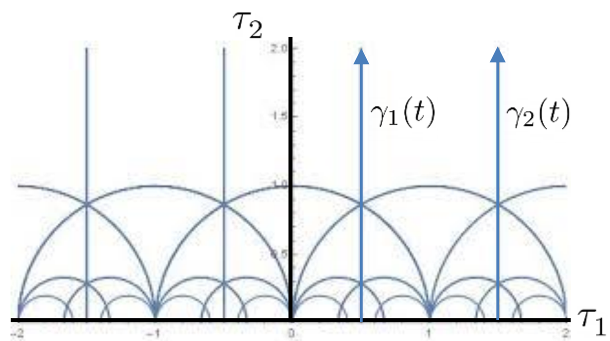

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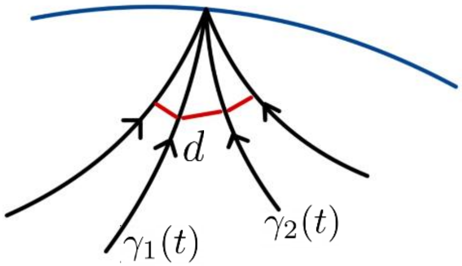

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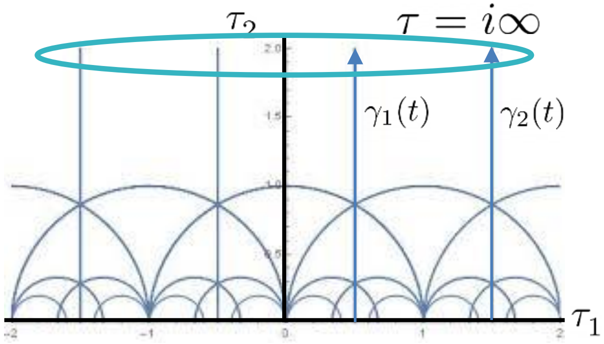

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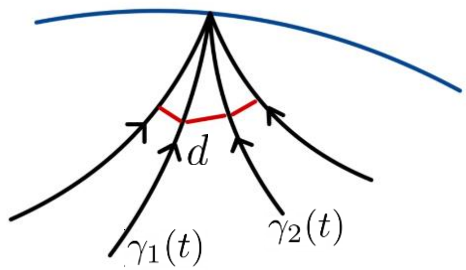

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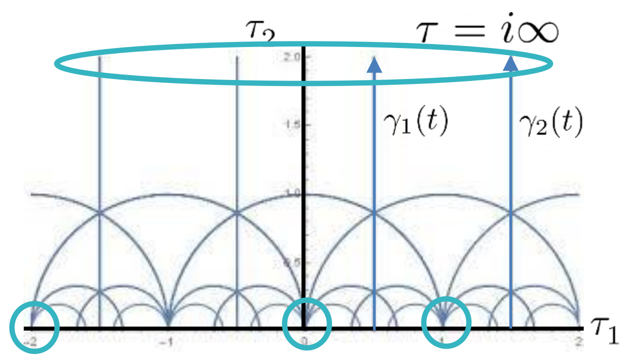

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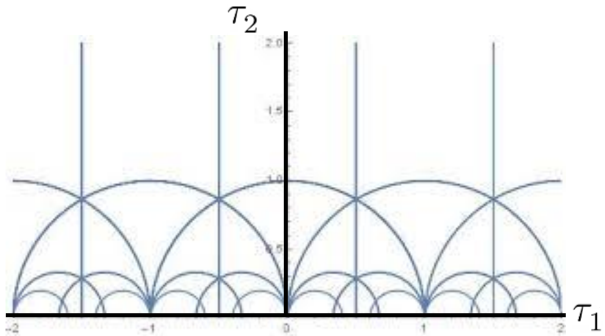

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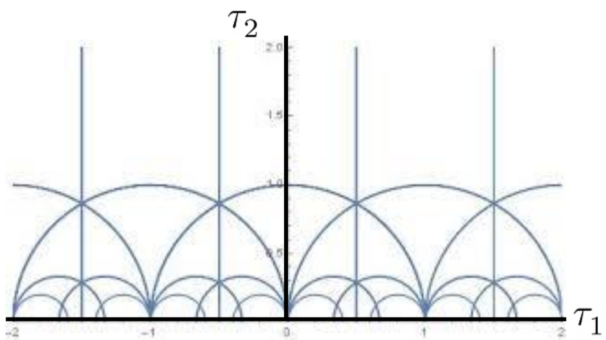

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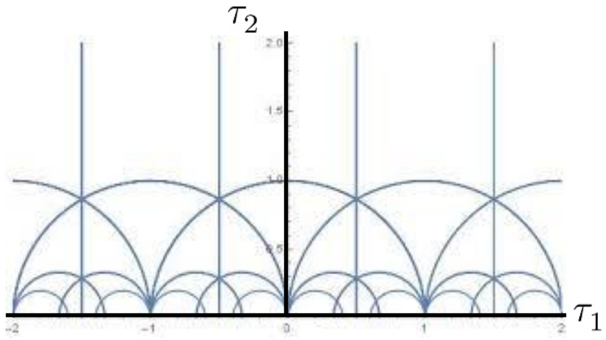

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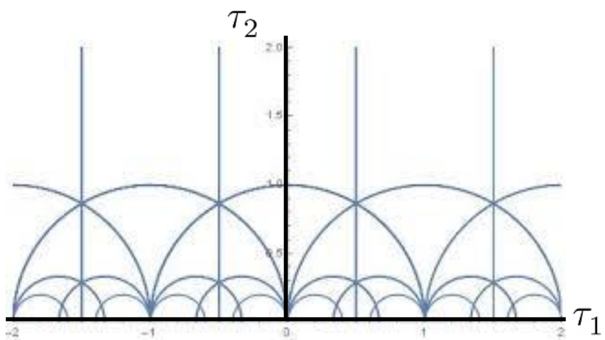

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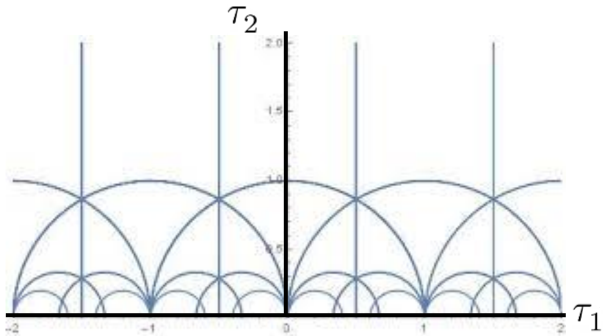

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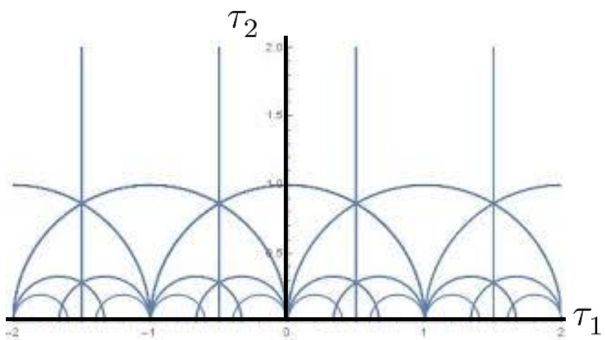

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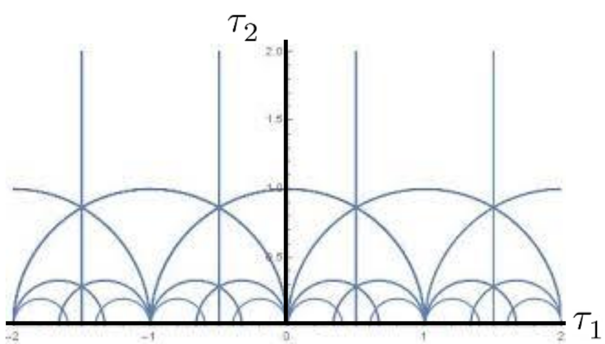

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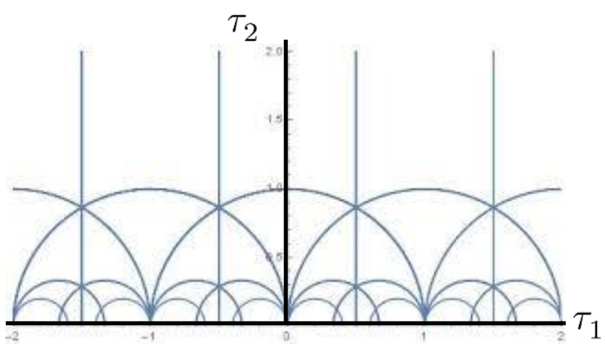

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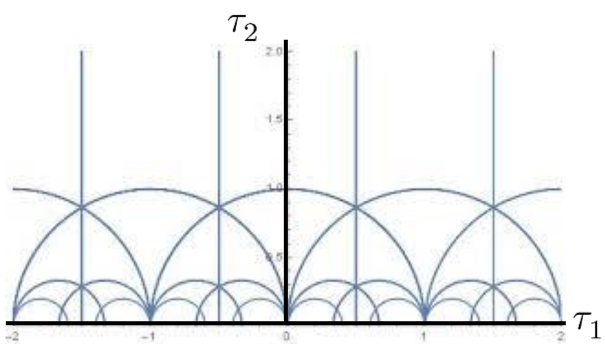

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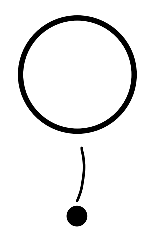

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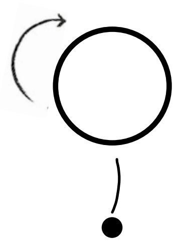

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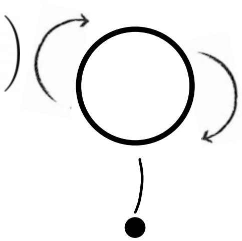

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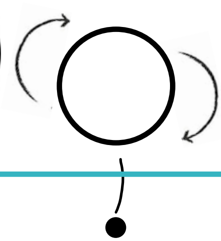

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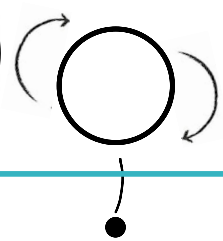

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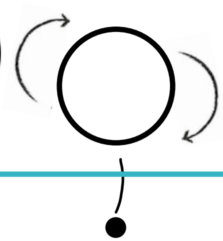

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- Only geodesics with rational compact moduli reach the boundary.

[Keurentjes, '06]

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- For $O(d,d)$ and $E_{d(d)}$ from string theory: always one equivalence class under the duality group.

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- Assuming a lattice of charges: explicit expression for the string spectum along the geodesic fixing the duality frame

  ⟶ SDC ✓

[Cecotti '15]

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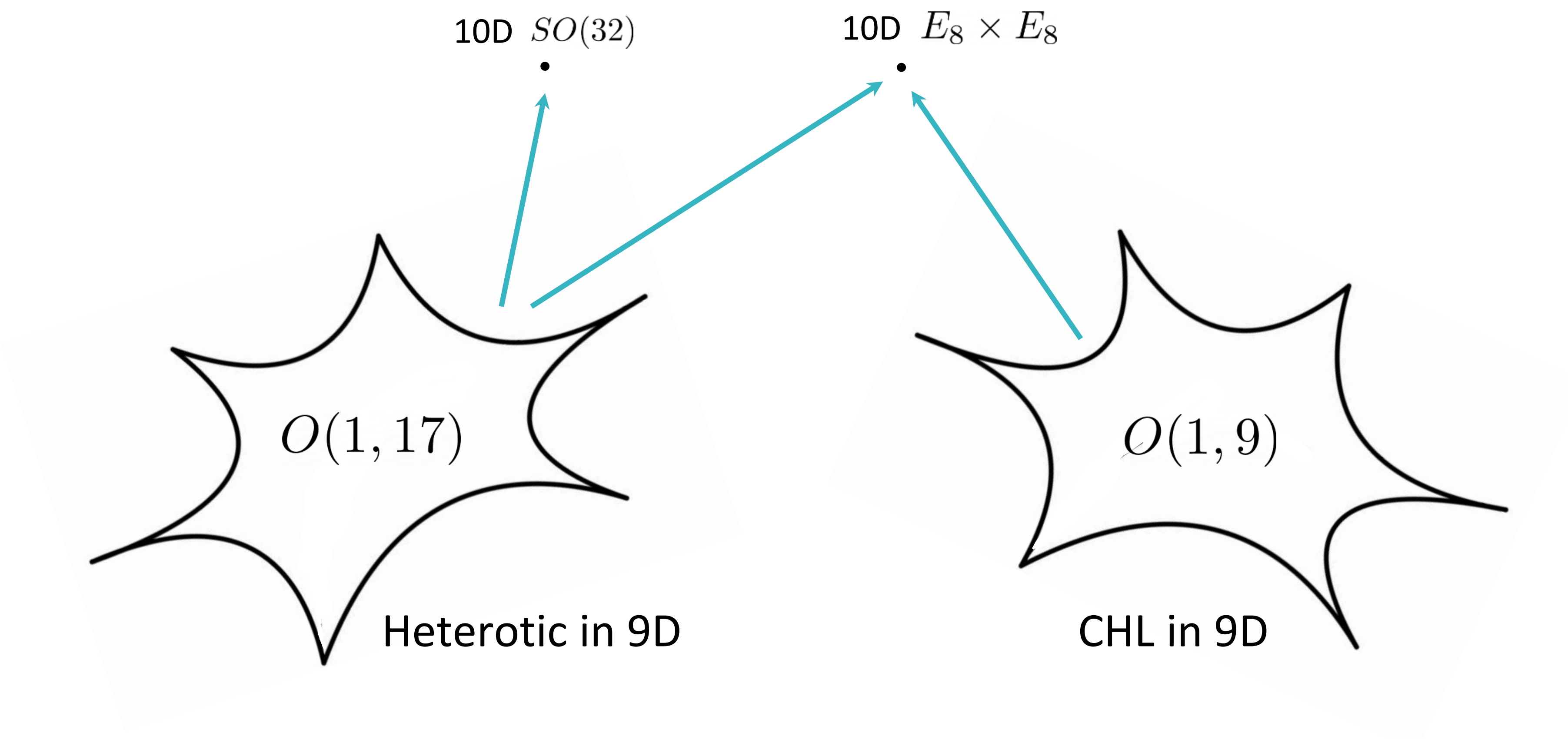

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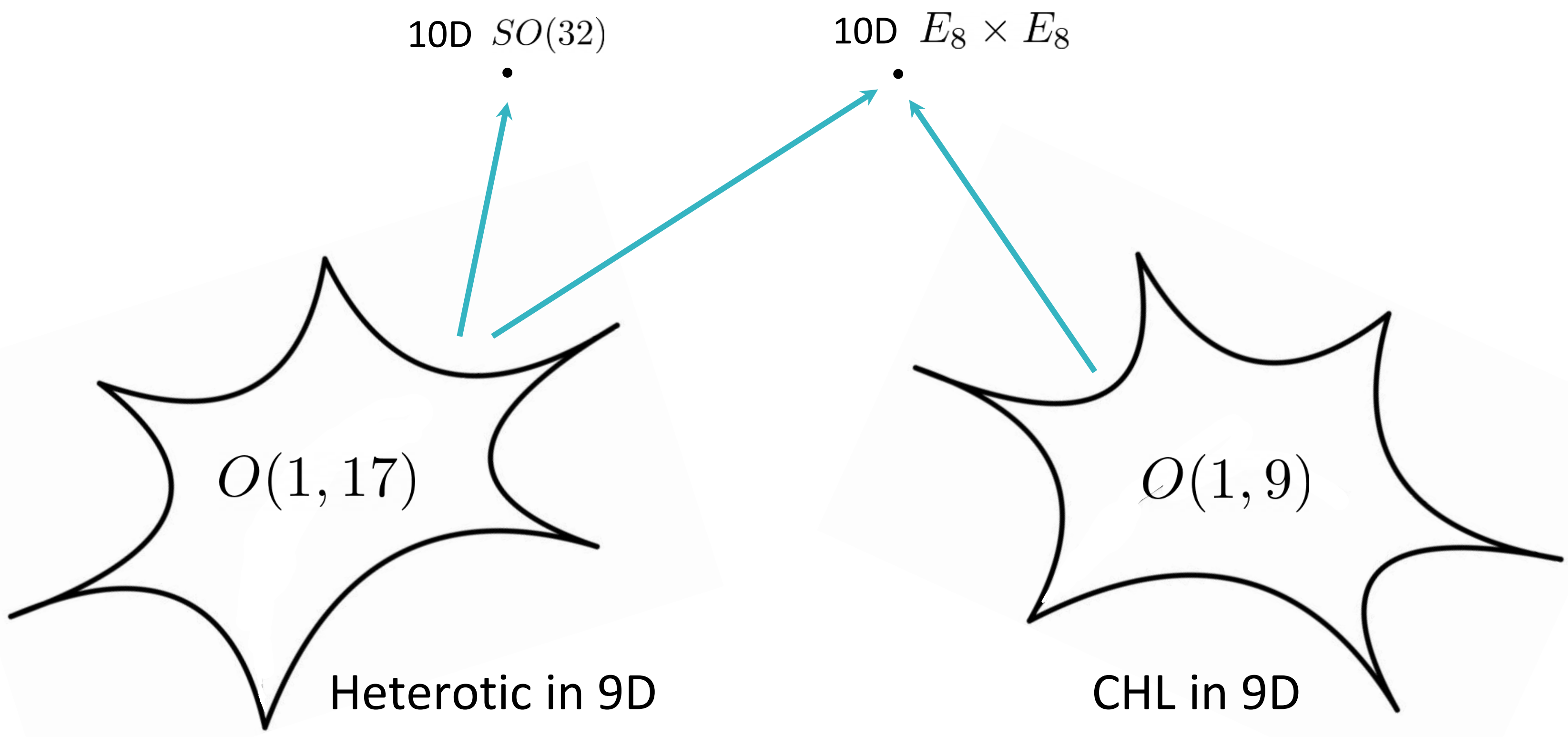

How do you see these limits from the lower dimensional perspective?

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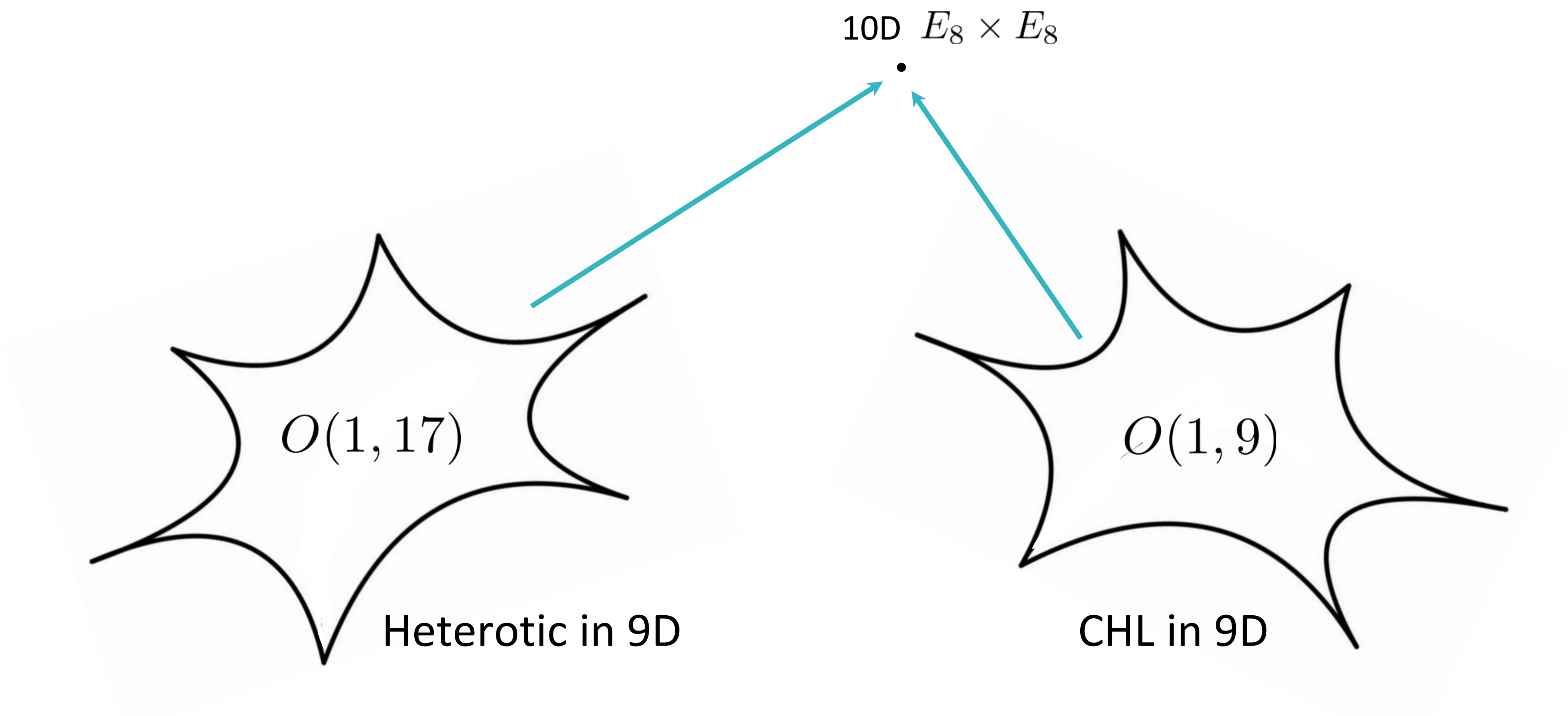

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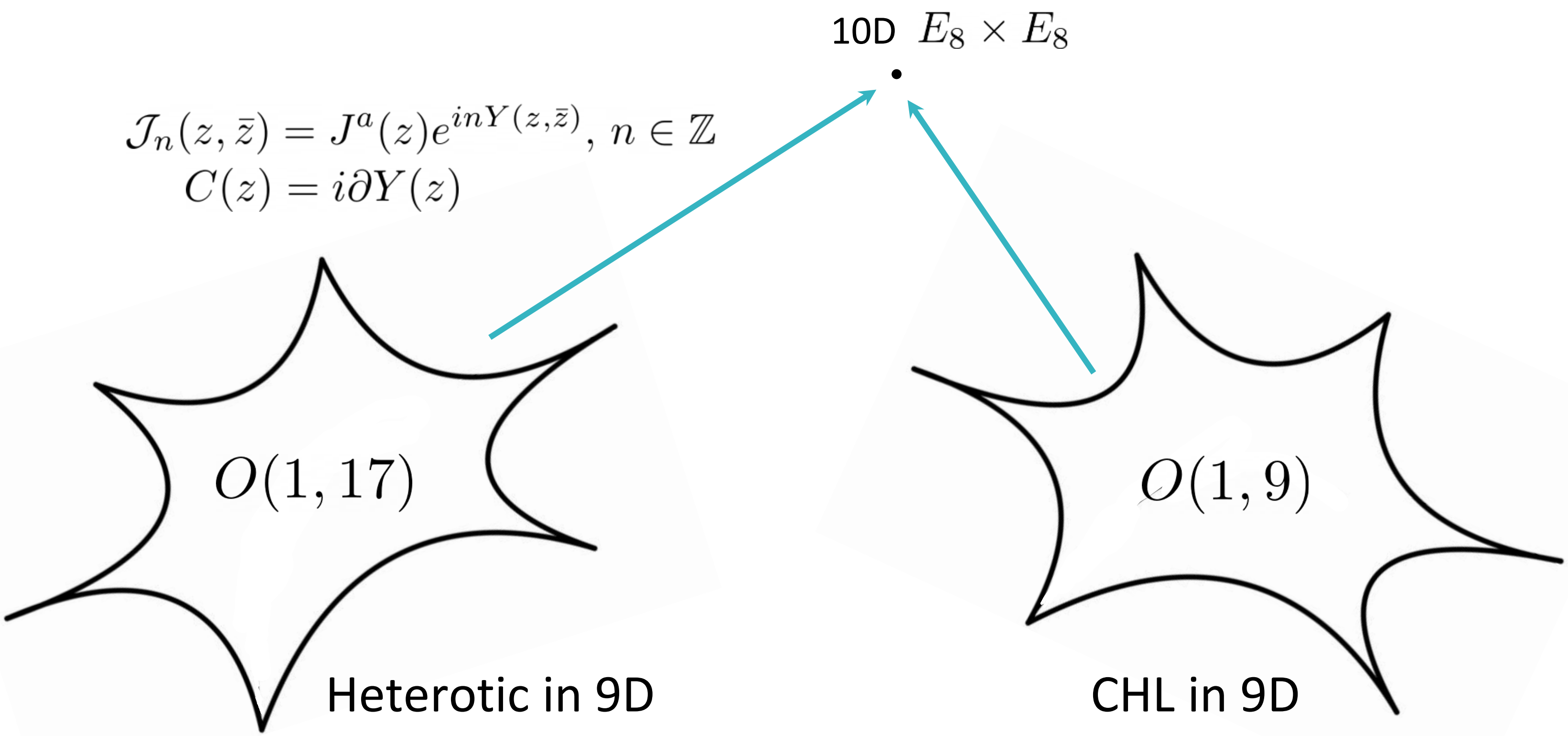
$$\mathcal{J}_n(z,\bar{z}) = J^a(z) e^{inY(z,\bar{z})}, \; n \in \mathbb{Z}$$
$$C(z) = i\partial Y(z)$$



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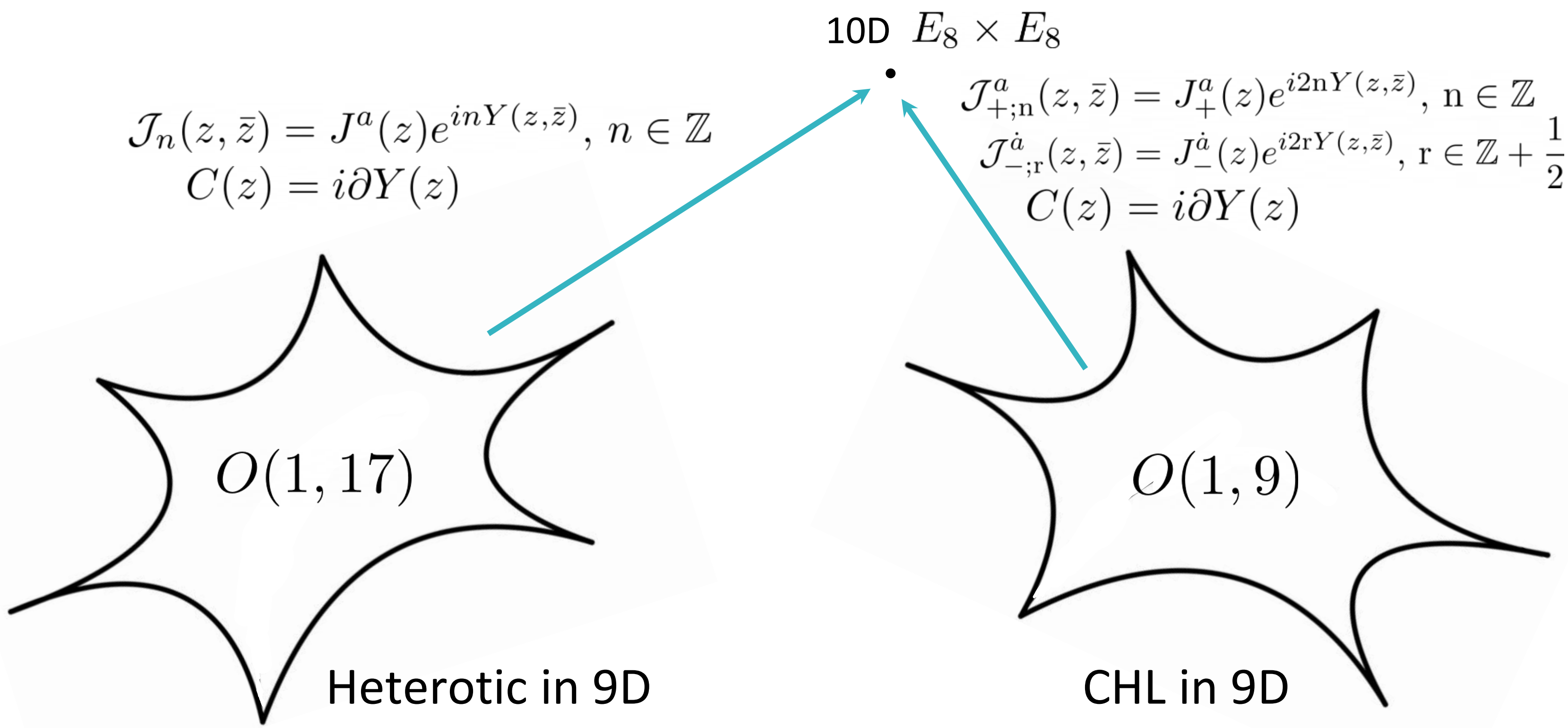

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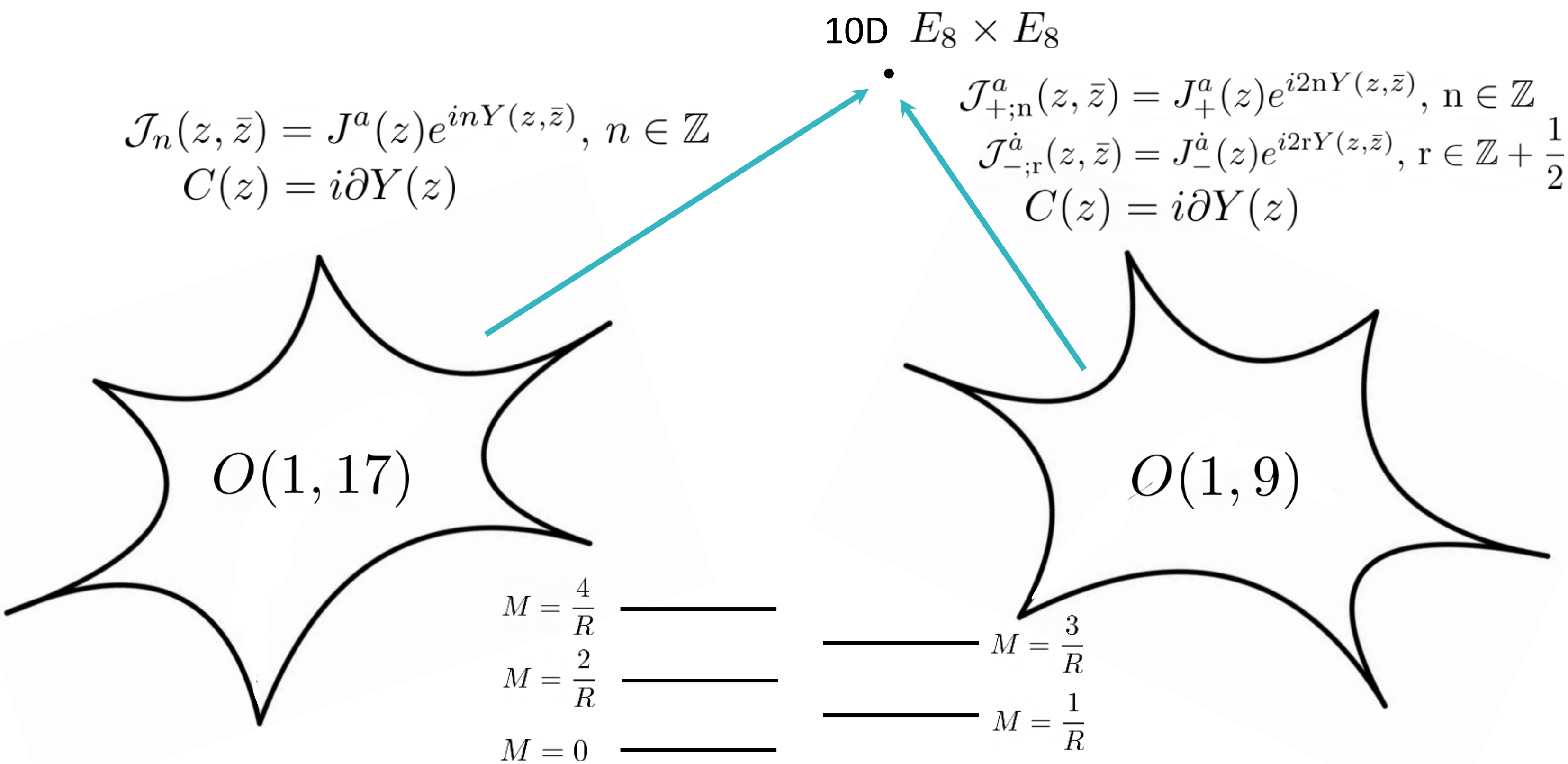

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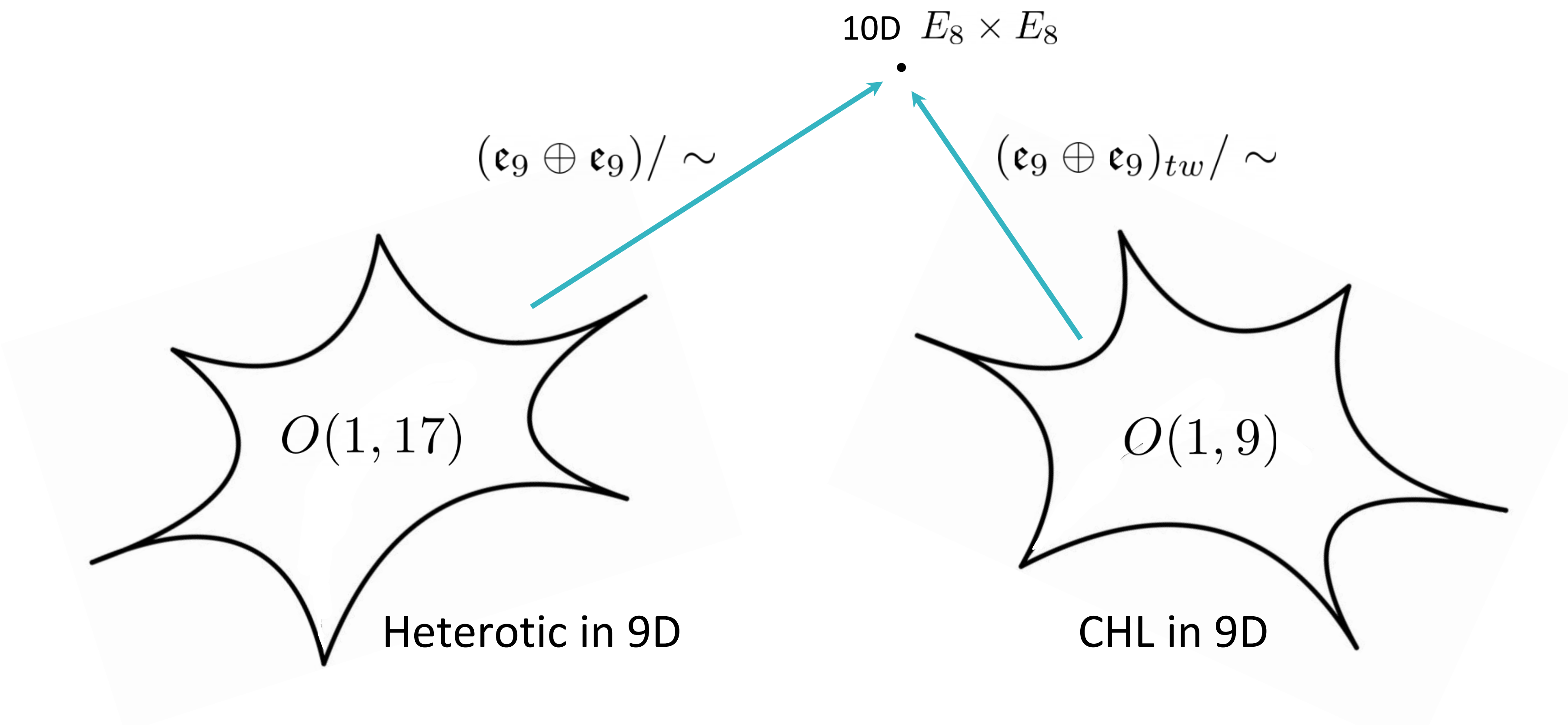

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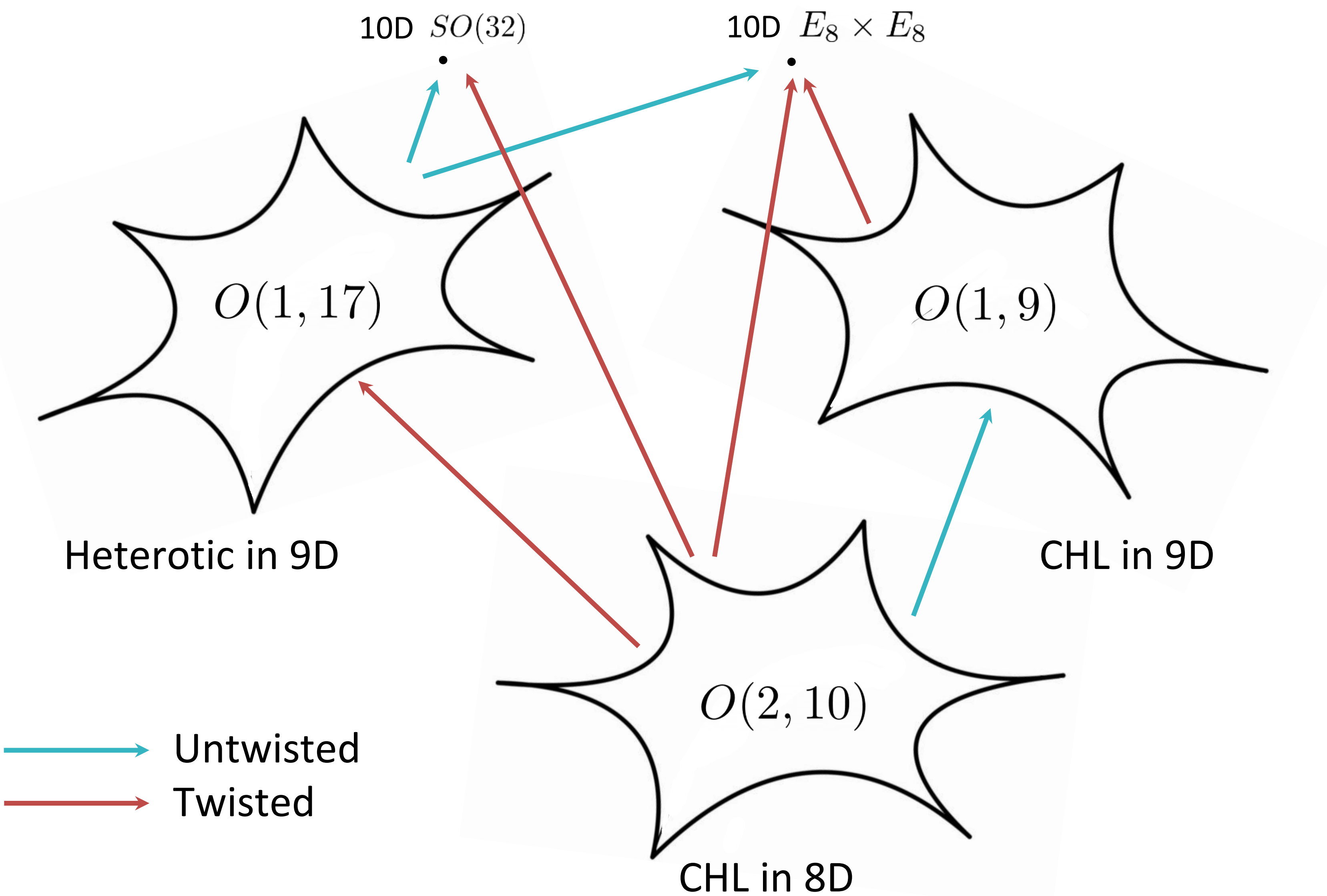
CHL string: decompactification limit



Conclusions

- The boundaries of the symmetric moduli spaces can be explicitly parametrized from the algebra.
- Assuming a charge lattice, the string spectrum in this limit is consistent with the SDC. [Cecotti '15]
- The physics of decompactification limits can be inferred from the current algebras, which come in their affine version from the point of view of the lower dimensional theory. [Lee, Lerche, Weigand, '21] [Cvetic, Dierigl, Lin, Zhang '22]
- Going from the CHL to the heterotic components of the moduli spaces leads to twisted affine algebras.

Thank you!