

PPG Cosmo workshop on Astrophysics, Cosmology and Gravitation

05 - 06 March, 2020

Federal University of Espírito Santo, Vitória, Brazil

Modelos análogos de baixas dimensões

Alberto Saa



Modelos análogos de baixas dimensões

Modelos análogos de baixas dimensões

Análogos de geometrias Riemannianas

QED Circuit

(Eletrodinâmica Quântica de Cavidades em Circuito)

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(Eletrodinâmica Quântica de Cavidades em Circuito)



Eduardo Miranda



Francisco Rouxinol

Article | Published: 03 July 2019

Hyperbolic lattices in circuit quantum electrodynamics

Alicia J. Kollár , Mattias Fitzpatrick & Andrew A. Houck

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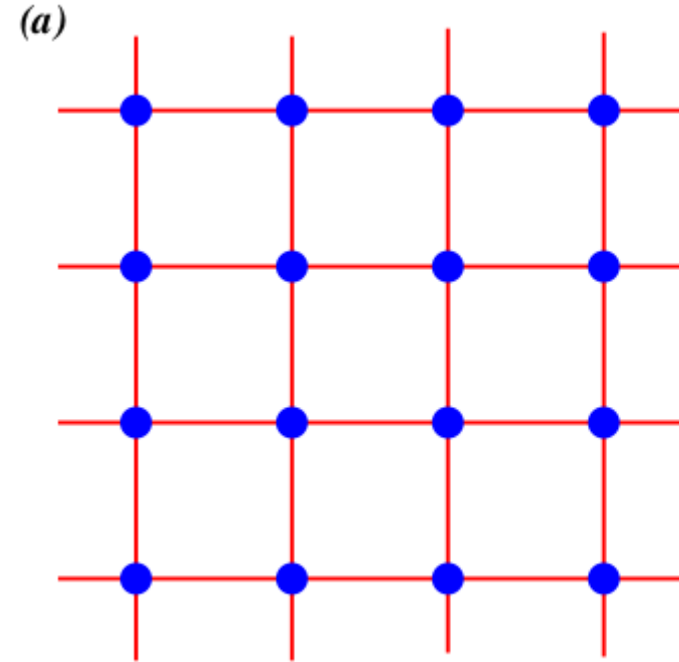
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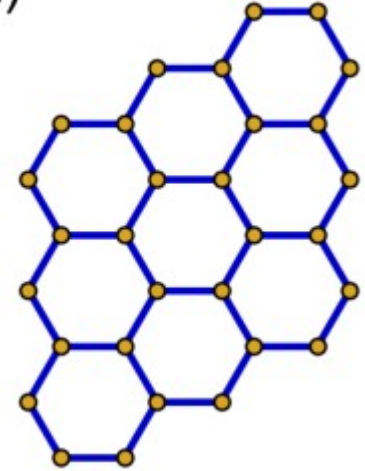
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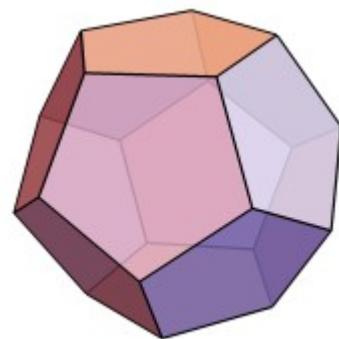
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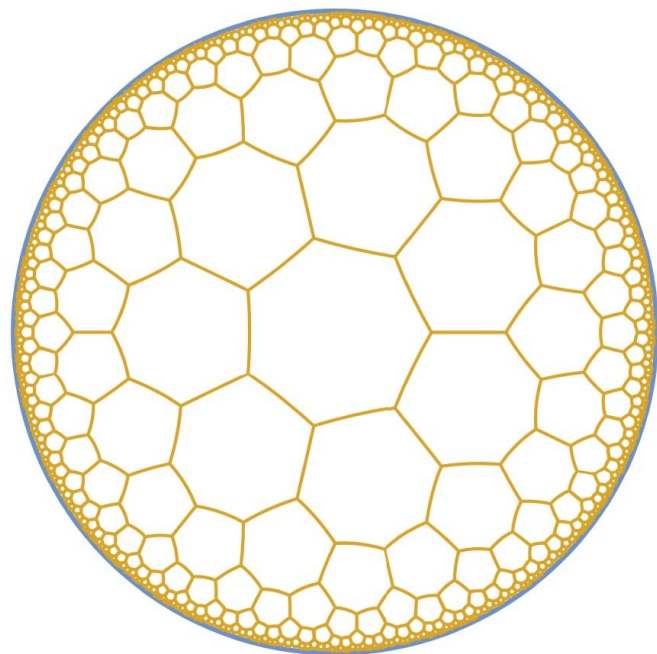
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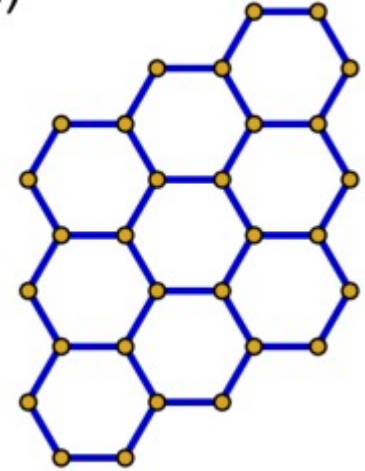
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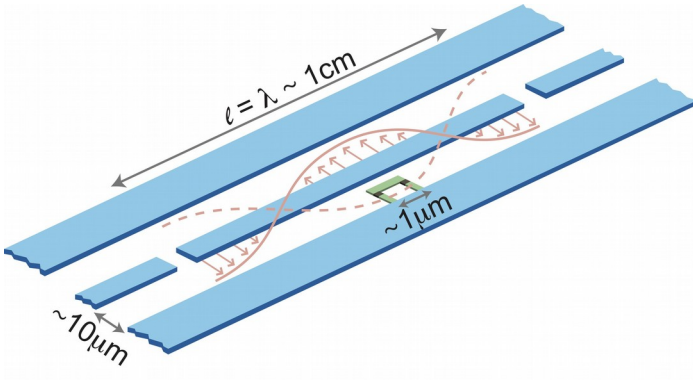
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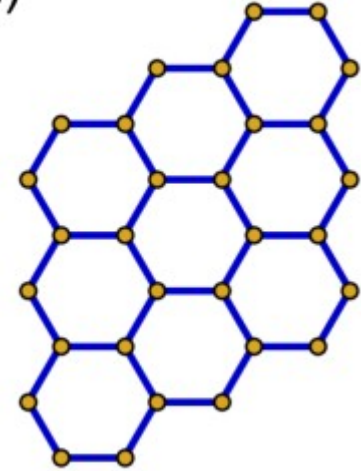
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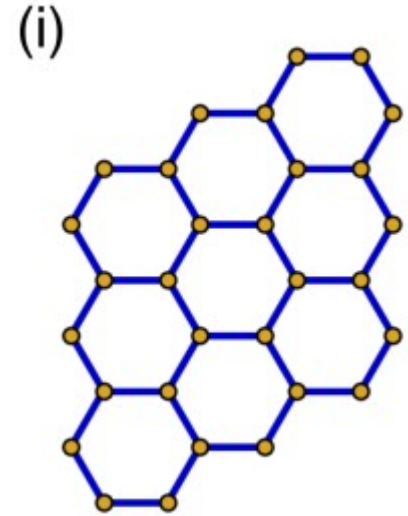
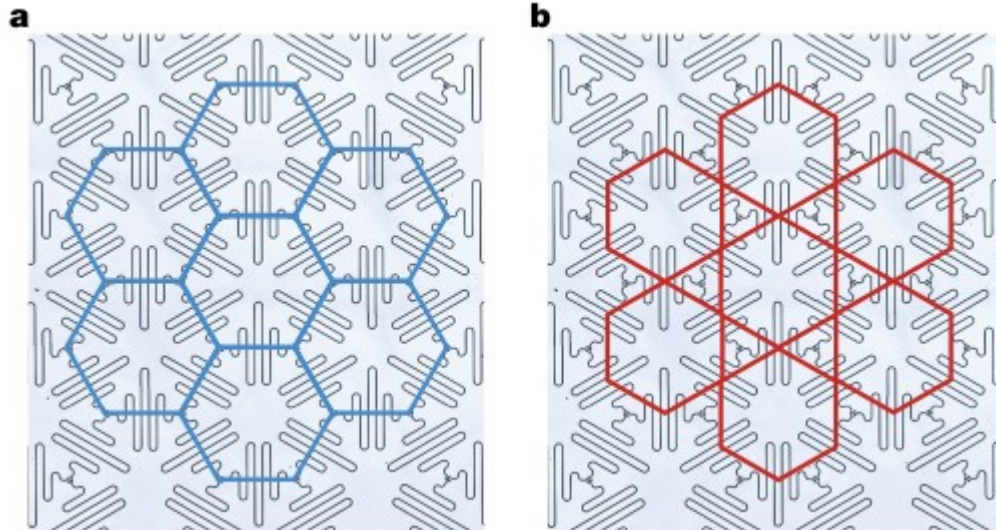
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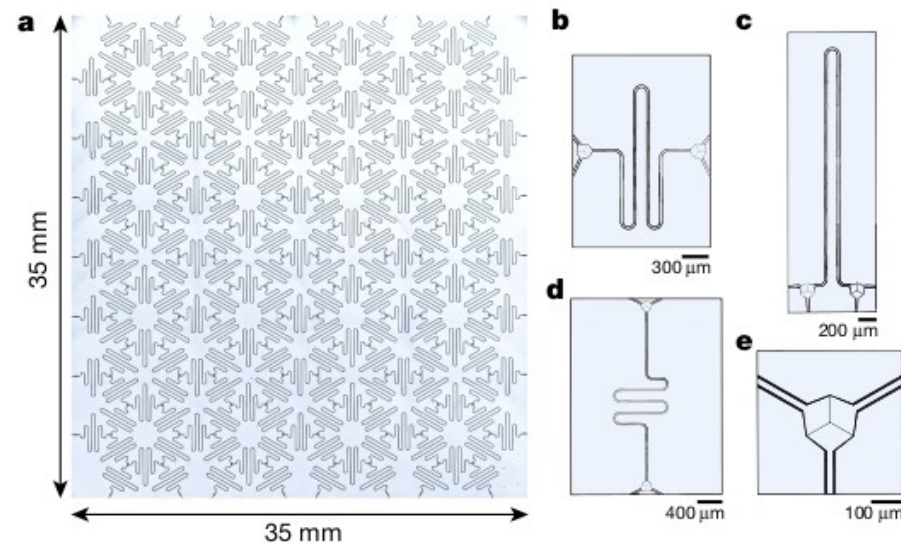
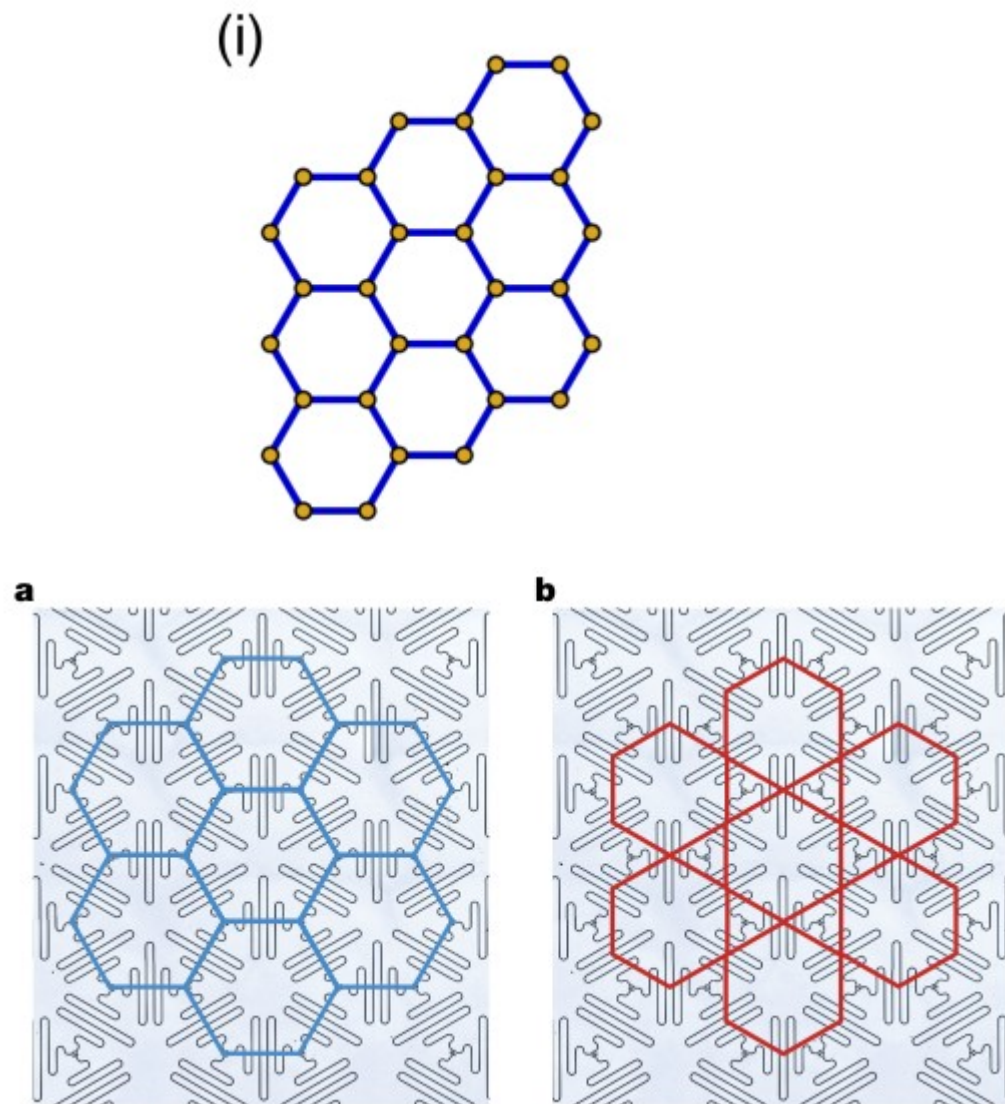
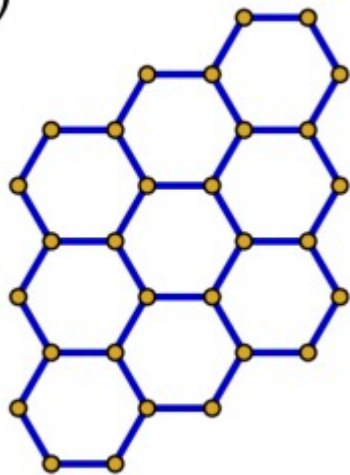
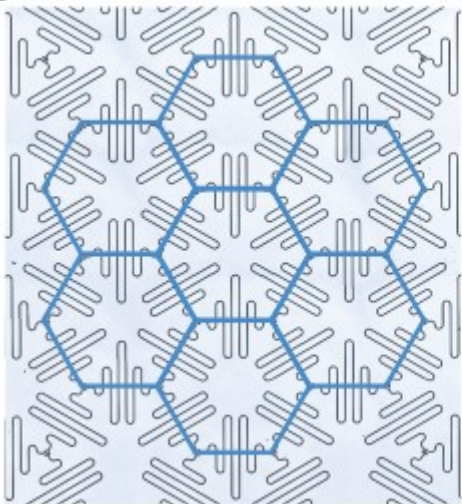


Fig. 1 | Circuit QED lattices. **a**, Picture of a Euclidean lattice of CPW microwave resonators, modified from ref. ¹⁹. **b–d**, Three mathematically identical resonators with different shapes but the same resonance frequencies and hopping rates. Scale bars: **b**, 300 μm ; **c**, 200 μm ; **d**, 400 μm . **e**, Close-up of a capacitive coupler like the ones used in **a–d** to connect three resonators together. Scale bar, 100 μm . The effective hopping rate at this junction is set by the capacitance between the three arrow-shaped centre pins.

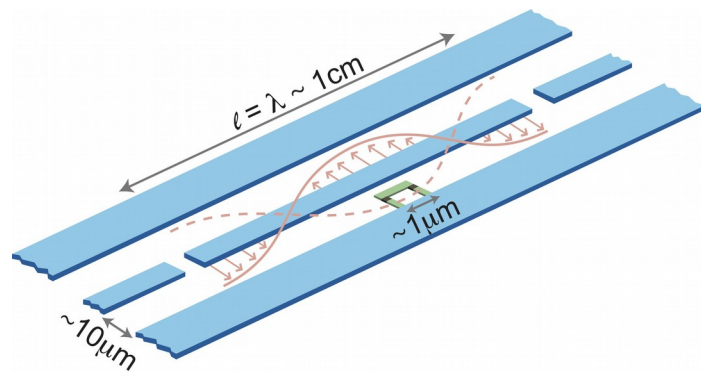
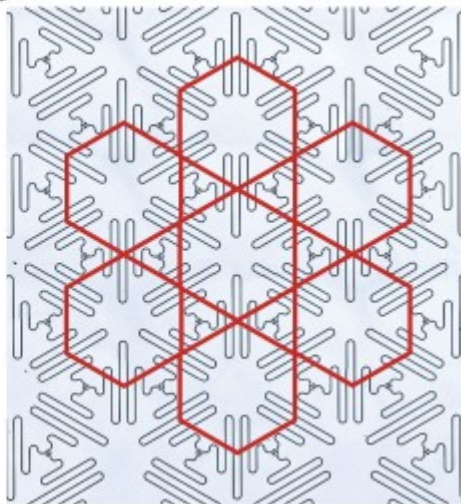
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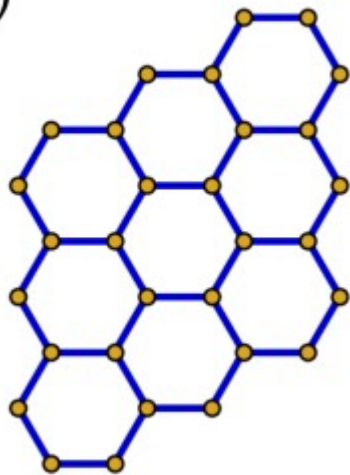
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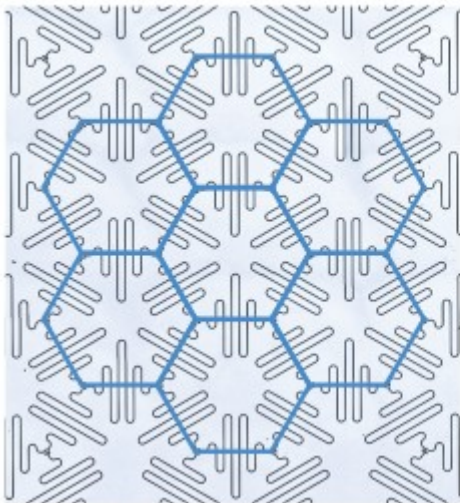
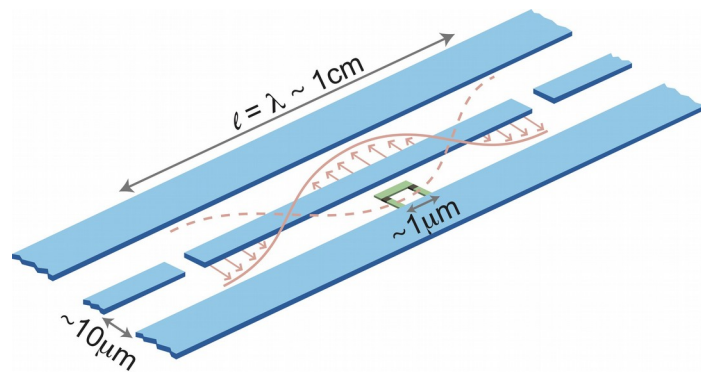
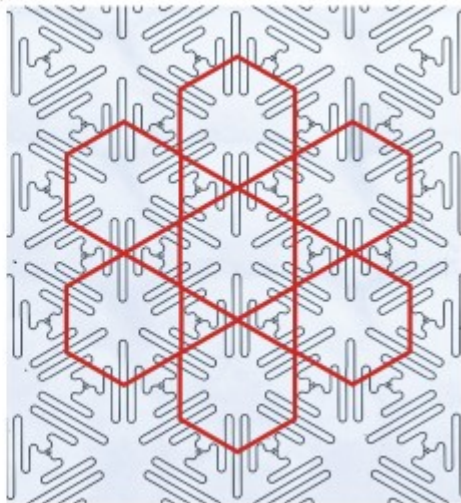
b



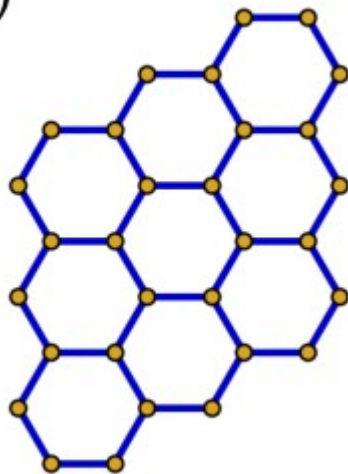
(i)



$$\mathcal{H}_{\Phi} = \sum_{\text{resonators}} \frac{cl}{4} \omega_0 (|\Phi_i^{(1)}|^2 + |\Phi_i^{(2)}|^2) + \sum_{\text{resonator ends}} \frac{1}{2} \omega_0 C_c \Phi^- \Phi^+,$$

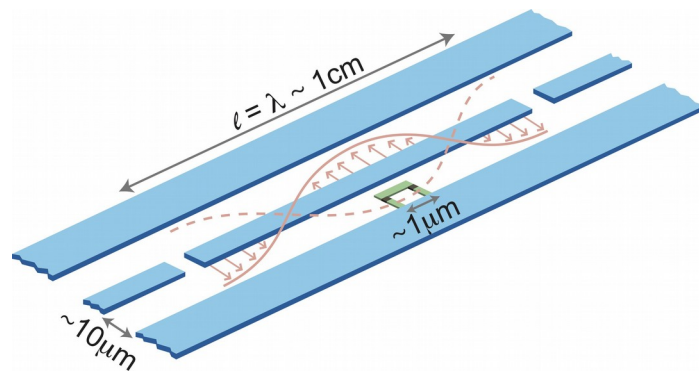
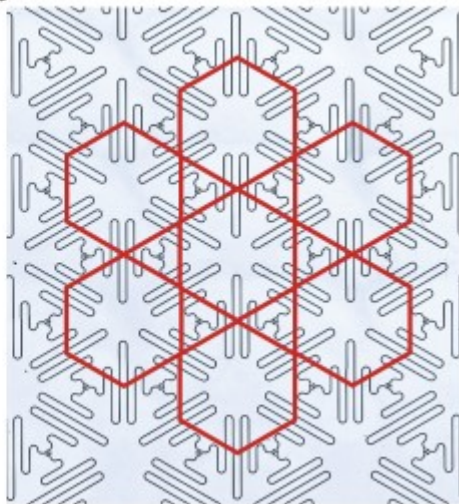
a**b**

(i)



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$$\mathcal{H}_{eff} = \sum_i \omega_0 a_i^{\dagger} a_i - \sum_{\langle i,j \rangle} t_{i,j} (a_i^{\dagger} a_j + a_j^{\dagger} a_i),$$

a**b**

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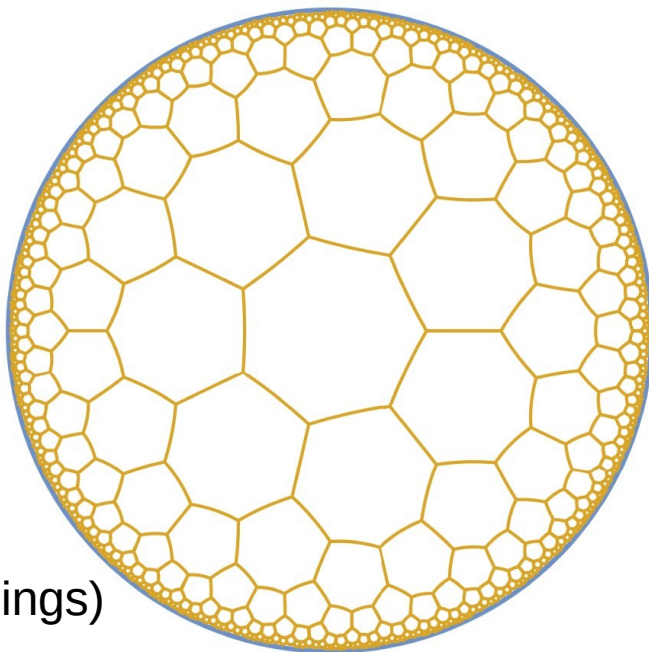
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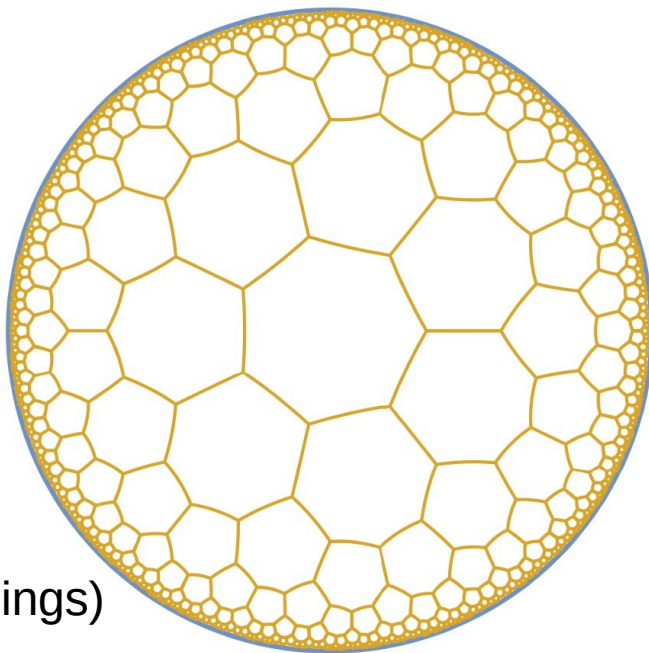
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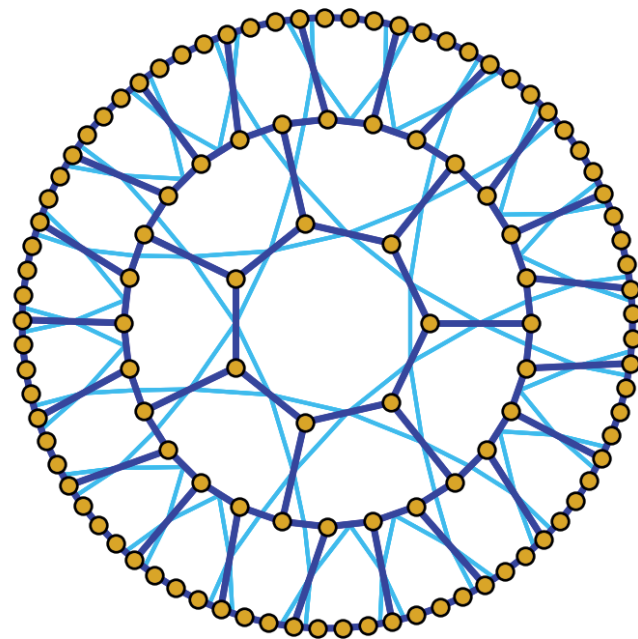
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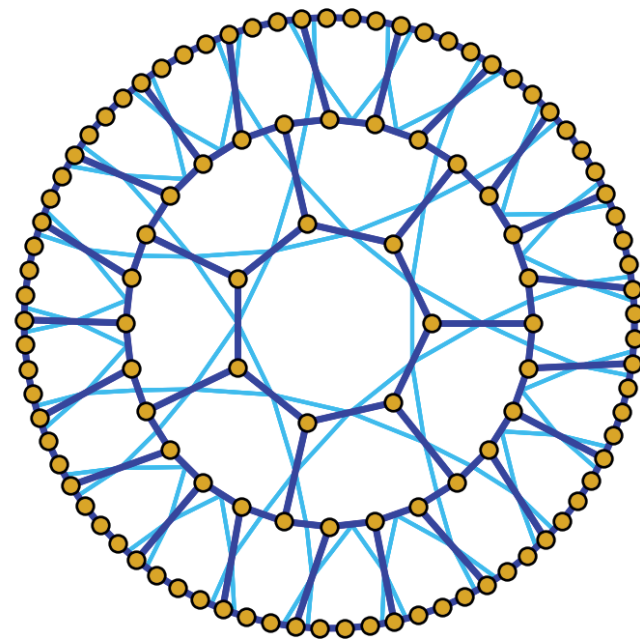
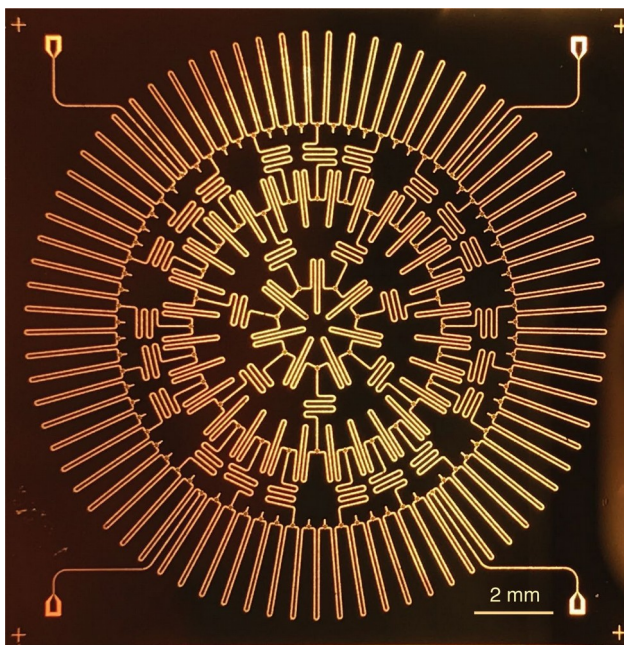


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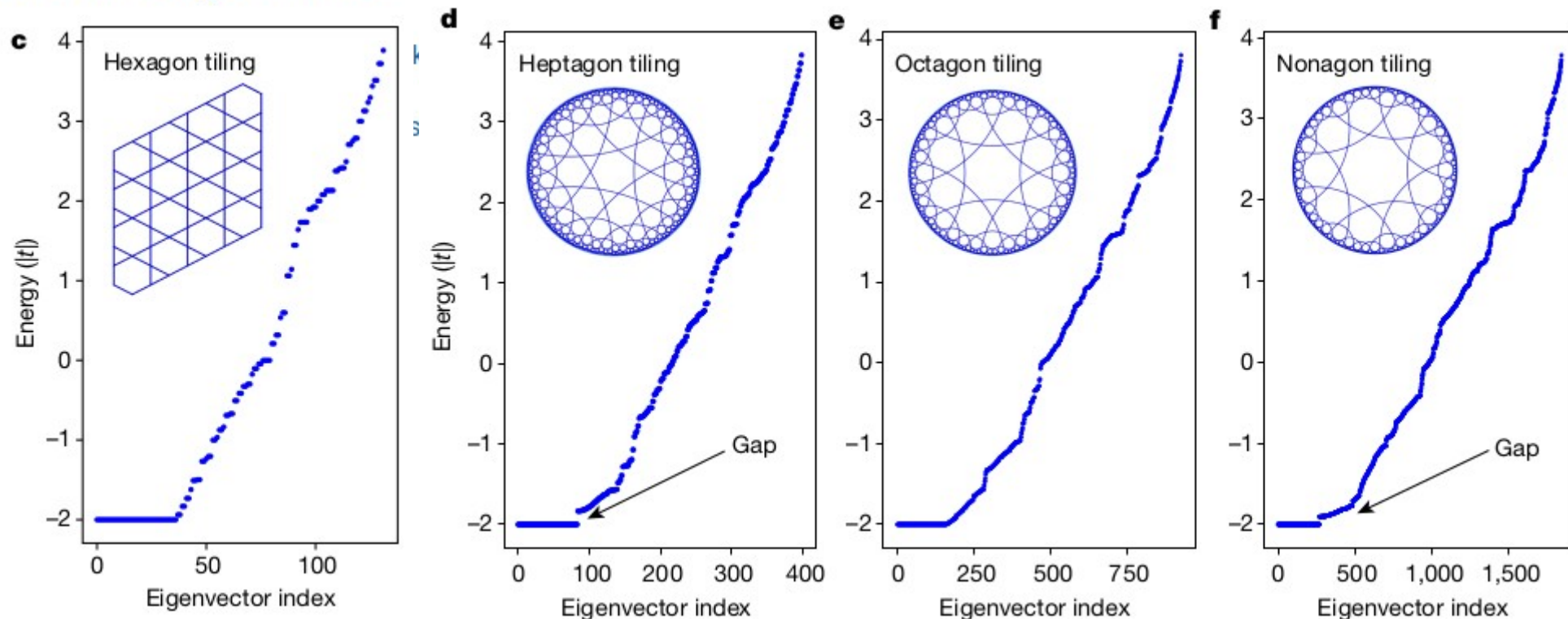
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$$D > 2$$

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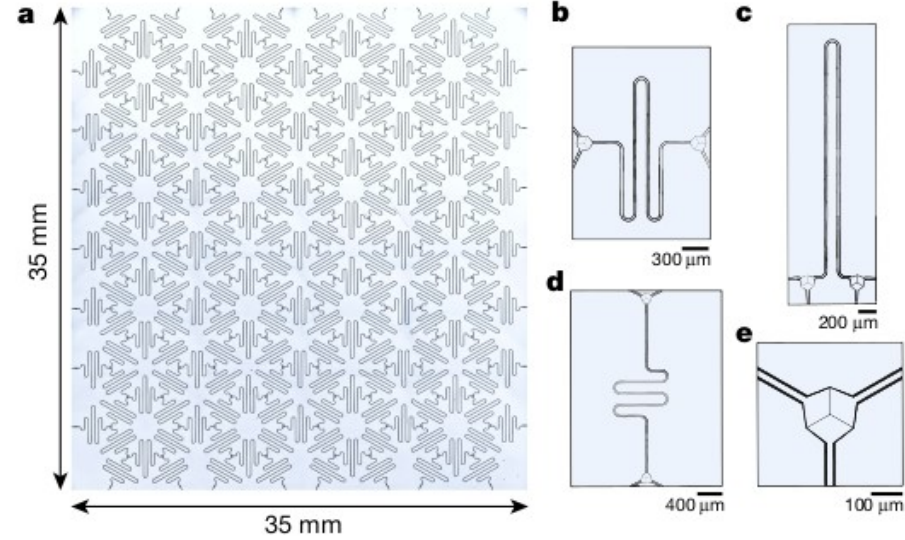


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$$D > 2$$

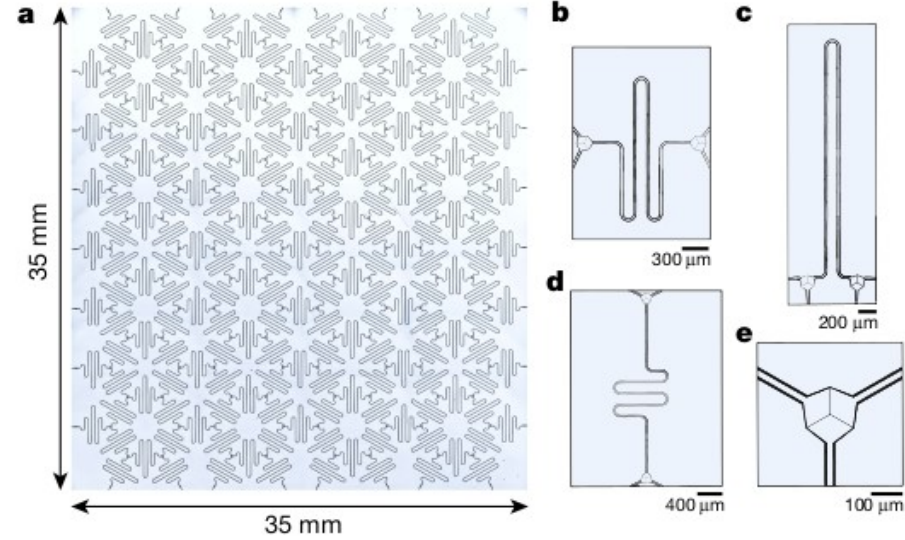
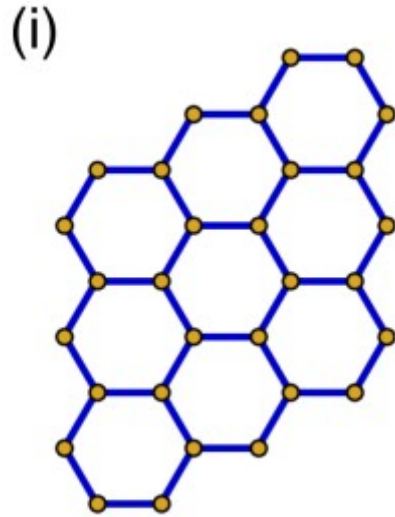


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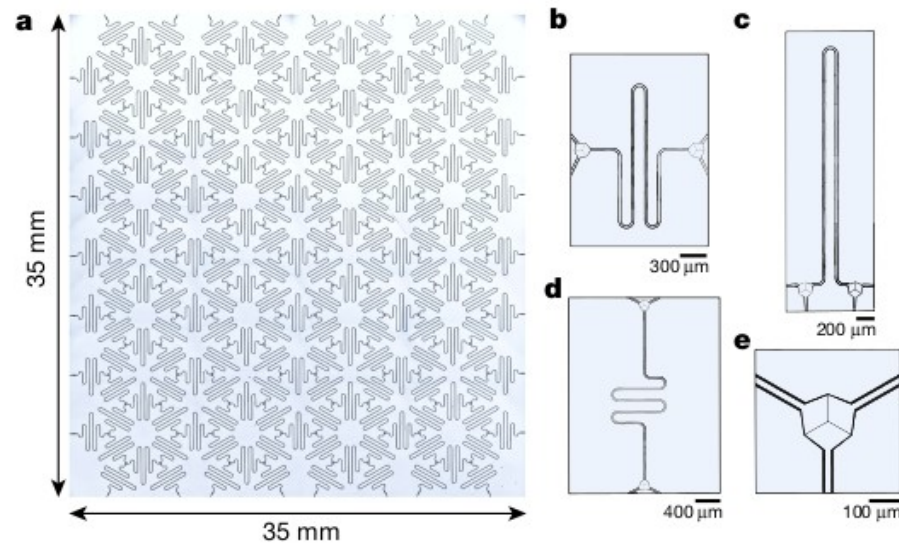
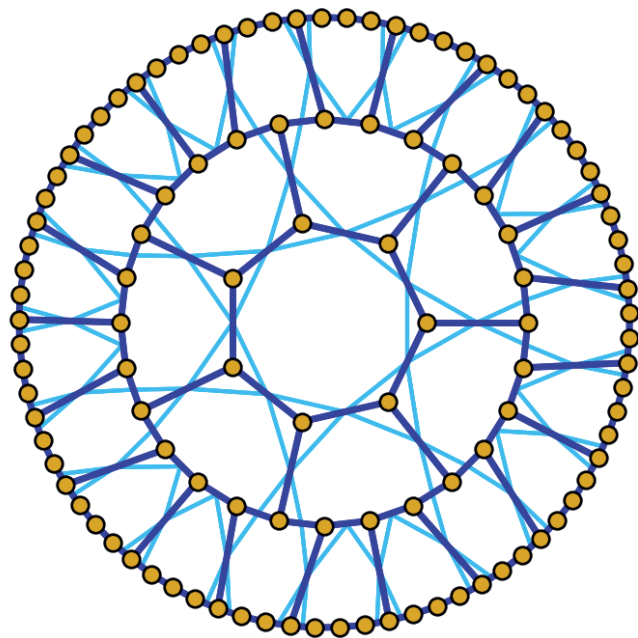


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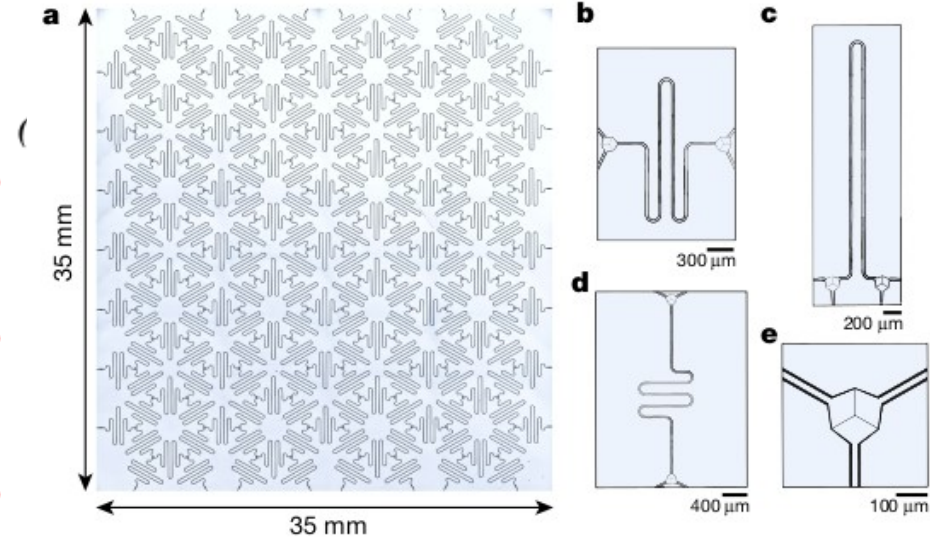
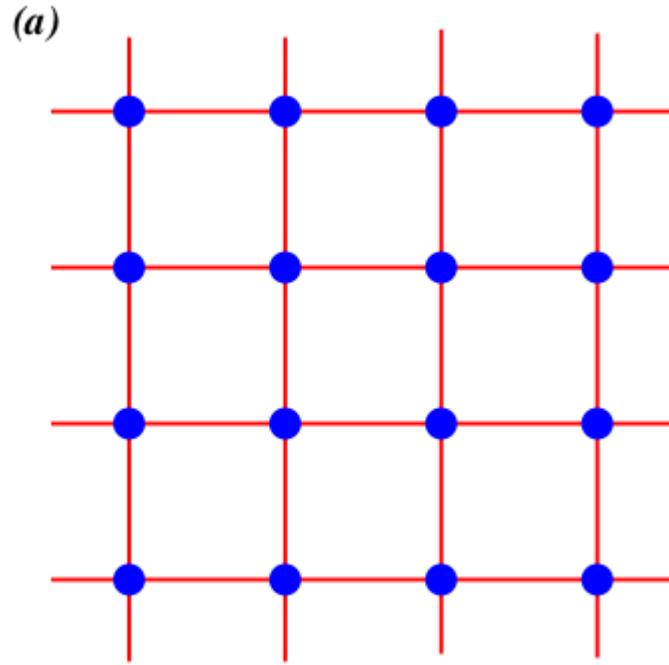
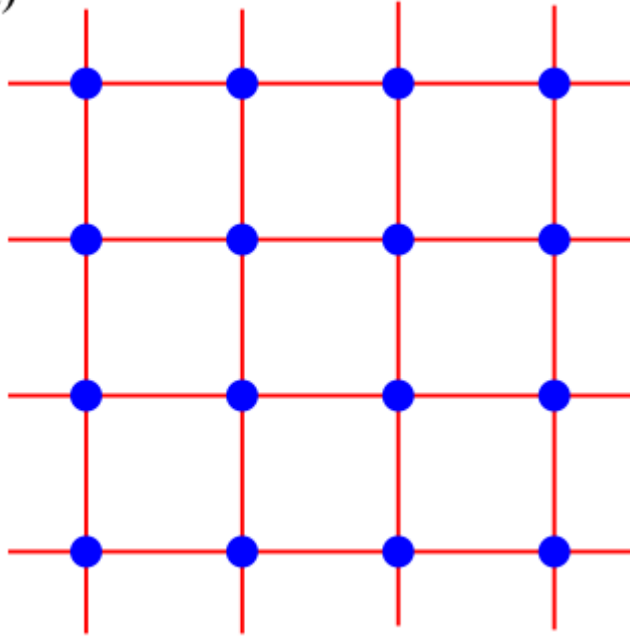


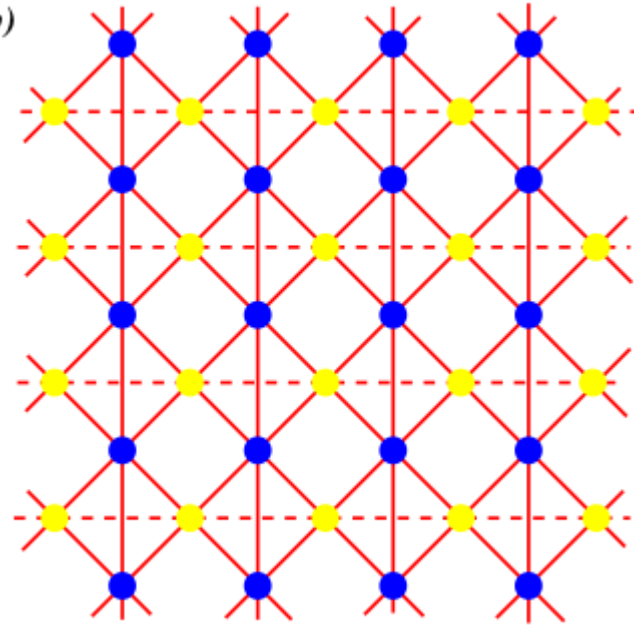
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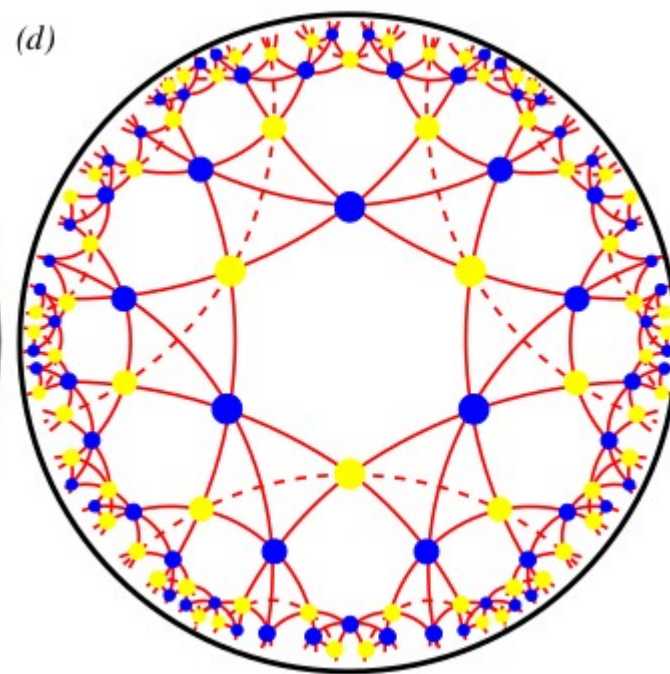
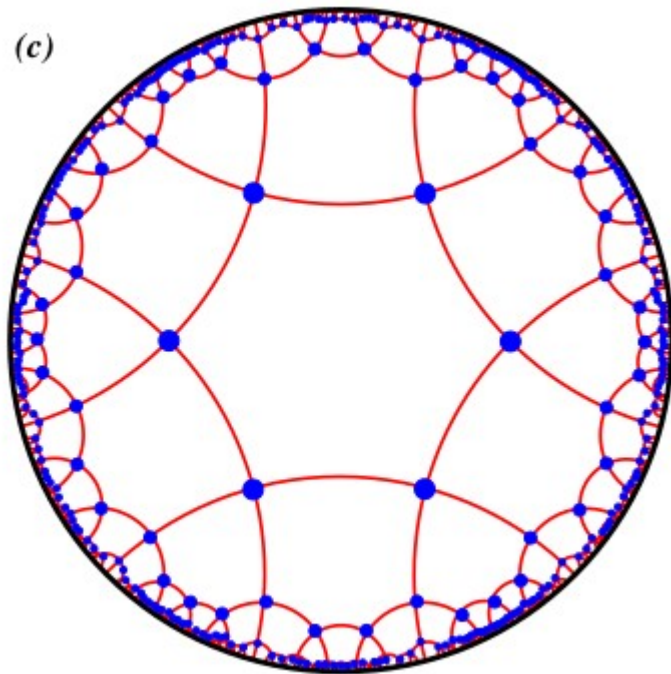
(a)



(b)

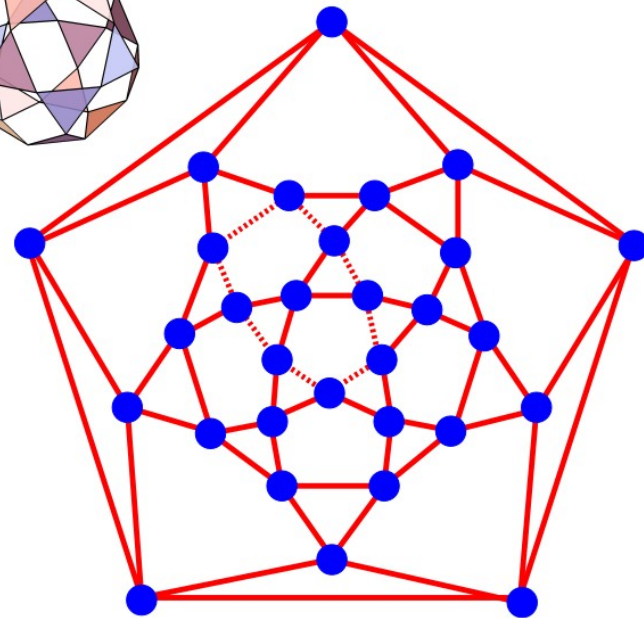
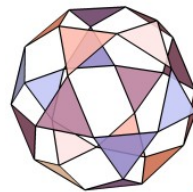
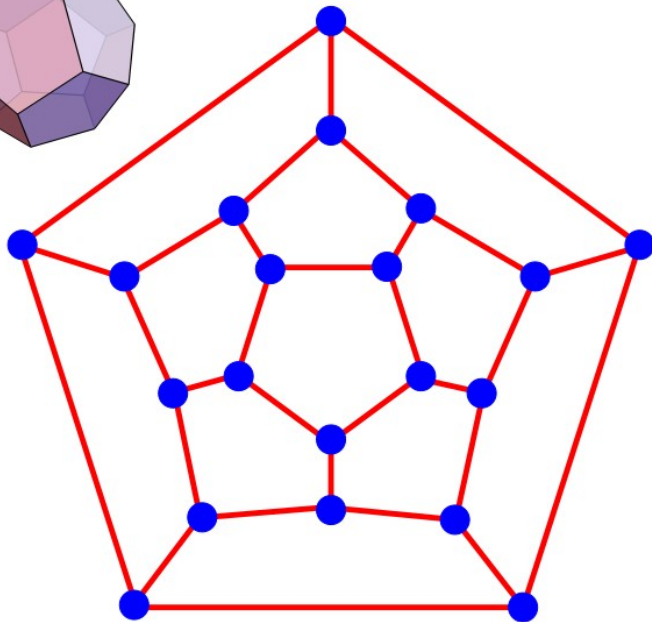
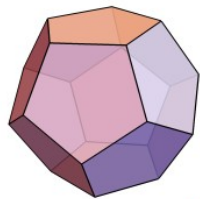


$D > 2$



Casos esféricos

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Horizontes(?)

Horizontes(?)

Elementos não lineares (diodos?)

Quebra de simetria T