Figures

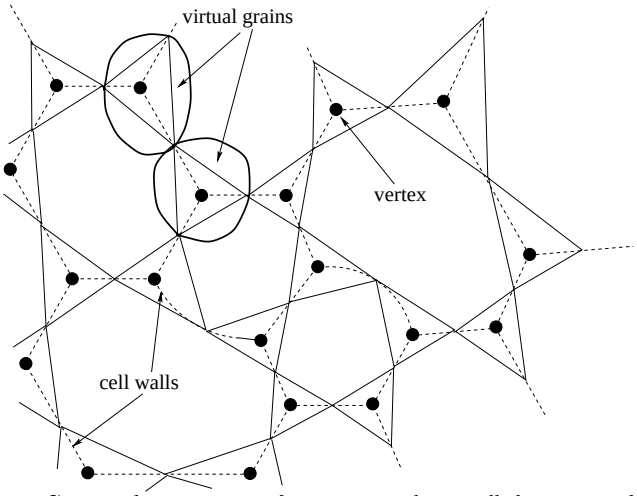

FIG. 1. The mapping from a trivalent cellular network onto an assembly of grains under external loading. The original cellular network is shown in dashed lines. The midpoints of the cell walls are joined to form triangles around each vertex (black circle). The grains of the equivalent granular assembly are centered on the vertices with the corners of the triangles representing contacts between neighboring grains. Two such virtual grains in contact are shown. Each grain is in contact with exactly three neighbors and therefore the granular assembly is exactly at the marginal rigidity state.

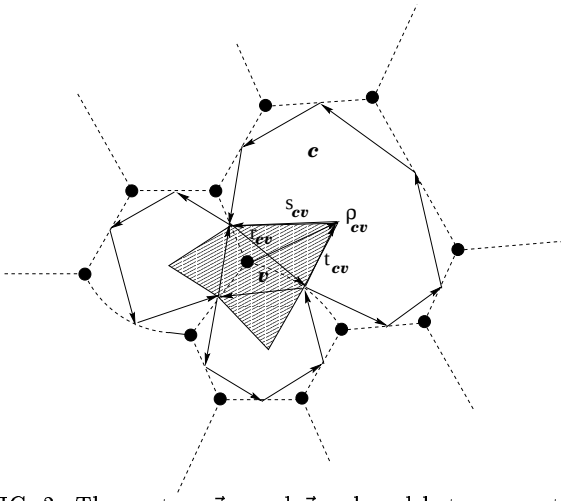

FIG. 2. The vectors $\vec{r}_{cv}$ and $\vec{\rho}_{cv}$ shared between vertex v and cell c. $\vec{r}_{cv}$ connects two neighboring wall midpoints and is one edge in a clockwise-directed triangle around vertex v. The vector $\vec{\rho}_{cv}$ points from vertex v to the centroid of cell c.

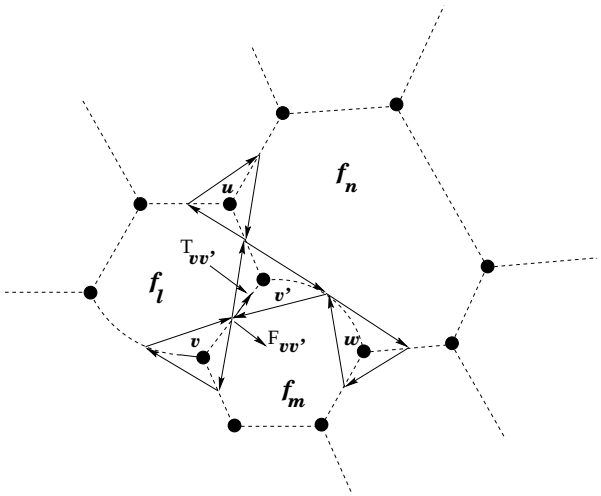

FIG. 3. The parameterization of the wall forces around vertex v' in terms of its neighboring cell forces. $\vec{f}_{vv'} = \vec{f}_l - \vec{f}_m$ is the force that triangle v exerts on triangle v'. The sign convention is that $\vec{f}_l$ is positive because the directed loop formed by the vectors $\vec{r}$ around cell l is *toward* triangle v' and vice versa for cell m.

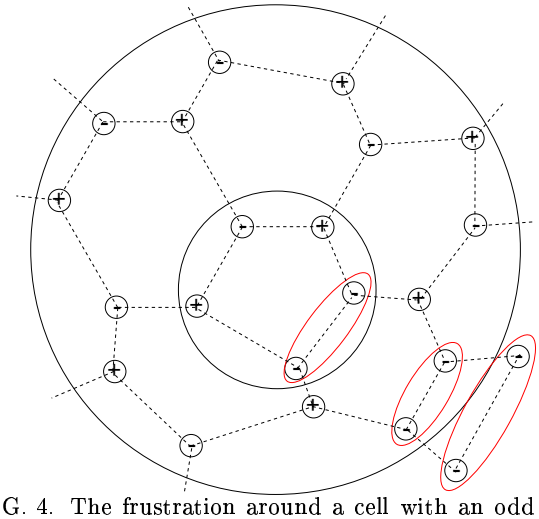

FIG. 4. The frustration around a cell with an odd number of edges (highlighted by the inner circle) surrounded by even-edged cells. Labeling the vertices around it alternately by + and - leads to two neighboring 'frustrated' vertices having the same sign (highlited by an elipse). Starting from a neighbor vertex of one of the frustrated vertices and labeling the next shell (confined within the outer circle), results in another frustrated pair lying adjacent to the first one (highlighted by another elipse). Continuing this procedure results in a line of such frustrated pairs emanating from the OEC, the first three of which are shown. This line can be capped only by encountering another OEC.

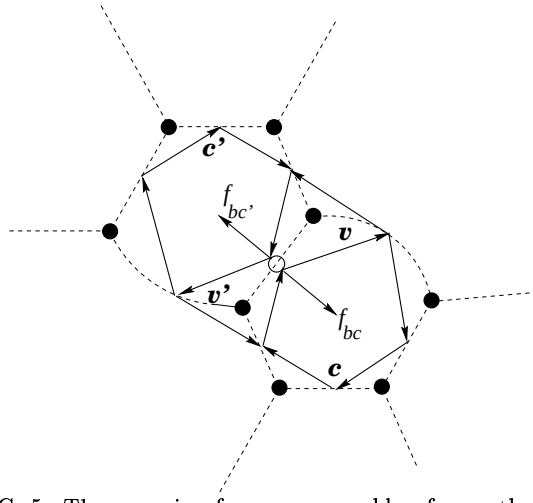

FIG. 5. The mapping from an assembly of smooth grains into a rough one with an equivalent geometry. The grains are considered to be centered on the cells with the vectors $\vec{r}$ connecting the contacts points around each one of them. Making all the grains rough and inserting a vanishingly small ball bearing (white circle) between touching grains at the contact maintains the original intergranular forces.