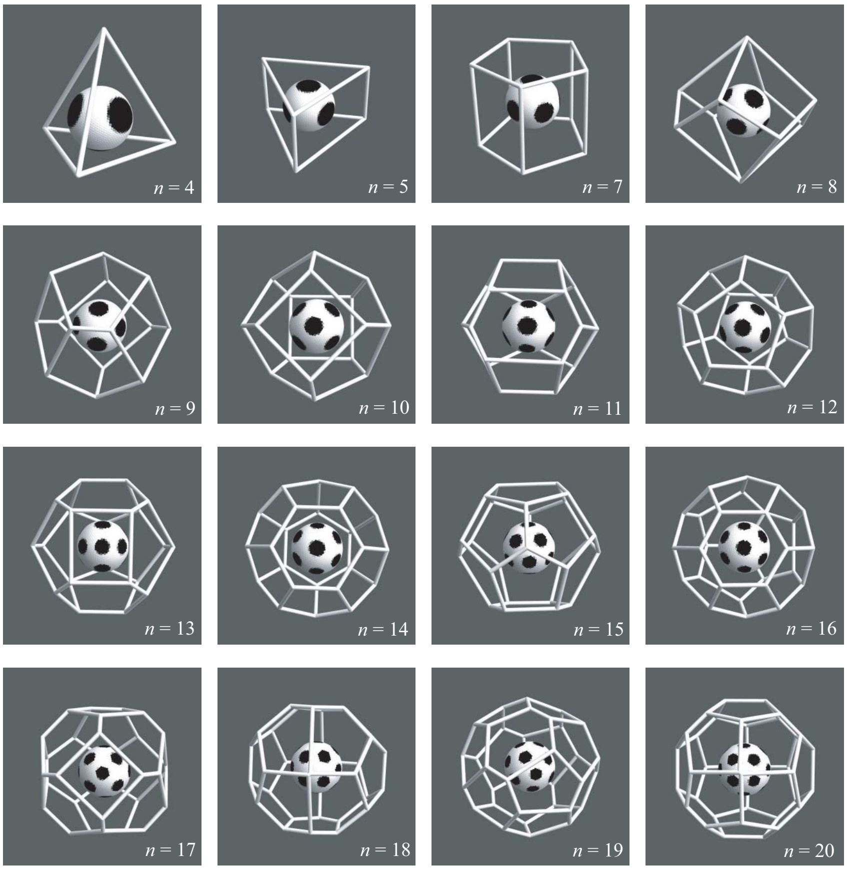

Fig. 6. Representative structures for each of n.

cording to the value of the corresponding grid point. As shown in Fig. 2, in all cases, u and v were almost complementary, and so, in the following discussion, we will focus on the stable patterns of v.

Figure 3 shows the approximating polygons with stable patterns for $R = 8.6$ and obtained from four different initial conditions. The resulting patterns show four different structures, and these also have different numbers of spots: 7, 8, and 9. Similar differences with different initial conditions were frequently observed, especially in cases with larger values of R. Therefore, we conclude that the structure of the stable pattern is dependent on the initial conditions. For this reason, we tried ten simulations for each value of R, each with a different seed of random number generator.

The number of spots n was also dependent on R. We let the value of R range from 4 to 15 at intervals of 0.2. Figure 4 shows the R dependence of n. The value of n has a tendency to increase with an increase in R. The approximated curve shown in Fig. 4 was quadratic, and the formula estimated using the least-squares method was $n = 0.0902R^2 + 0.219R - 0.686$. Figure 5 shows a comparison of the stable patterns obtained using the different radii, which were proportional to R. For the same values of the parameters, the radii of the spots were approximately the same. This supports the conclusion that the relation between R and n is quadratic.

The approximating polyhedrons revealed in detail structural properties of the stable patterns. Figure 6 shows representative results for each value of n except for $n = 6$. The result for $n = 6$ was shown in Fig. 1. For the representative structures, we chose the results for which the Coulomb energy had the smallest values for a given value of n. As n increases, the structure tends to be more complex and less ordered. For small values of R, we observed highly ordered patterns, regular polyhedrons. For $n = 4, 6$, and 12, the Platonic polyhedrons [14] were observed. We did not observe an octahedron ($n = 8$) or an icosahedron ($n = 20$). When $n = 8$, we observed a shape that was slightly different from an octahedron. Prisms, another kind of ordered structure, were observed for $n = 5, 6$, and 7. Other types of regular polyhedrons, such as Archimedes polyhedrons, were not observed.

Both the total number of vertices and the degrees of the vertices were dependent on n. When n was small, regular triangles and regular squares were frequently observed. On the other hand, when n was large, pentagons and hexagons were common. In many cases, they were almost equilateral or almost equiangular; however, irregular polygons were observed in some cases. A vertex of degree three was dominant in all cases except for a few cases with large R. In such cases, a vertex of degree four was observed.

Table 1 shows a summary of the basic properties of the representative results: the number of polygons; the number of i-gons for $i = 3, 4, 5$, and 6; the Coulomb energy; the Coulomb angle; the structural property of the polyhedron; and the number of other structures. We introduce the Schoenflies notation in order to summarize the symmetry properties of the various polyhedrons, and this is