Preface

As well-known quasicrystals with 12-fold symmetry observed since 2004 in liquid crystals, colloids, polymers and nanoparticles have been received a great deal of attention. In particular, 18-fold symmetry quasicrystals in colloids were discovered in 2011. More recently the quasicrystals with 12-fold symmetry were also found in giant surfactants. The formation mechanisms of these kinds of quasicrystals are connected closely with self-assembly of spherical building blocks by supramolecules, compounds, block copolymers and so on and are quite different from that of the metallic alloy quasicrystals. They can be identified as soft-matter quasicrystals exhibiting natures of quasicrystals with soft-matter characters. Soft matter lies in the behaviour of intermediate phase between solid and simple fluid, while the nature of quasicrystals exhibits importance of symmetry as they are highly ordered phase. These features are very complex yet extremely interesting and attractive. Hence, they have raised a great deal of attention of researchers in physics, chemistry and materials science.

All the observed soft-matter quasicrystals so far are two-dimensional quasicrystals. It is well known that two-dimensional quasicrystals consist of only two distinct types from the angle of symmetry theory, one being 5-, 8-, 10- and 12-fold symmetries, the other being 7-, 9-, 14- and 18-fold according to the symmetry theory. Therefore, two terminological phrases can be defined such as the first and second kinds of two-dimensional quasicrystals respectively. The two-dimensional solid quasicrystals observed so far belong to the first kind ones only, while soft-matter quasicrystals discovered up to now can be in both kinds. This may imply that many new types of soft-matter quasicrystals in addition to those with 12- and 18-fold symmetries may be observed in the near future. Hence, the interdisciplinary studies on soft-matter quasicrystals present great potential and hopeful research topics.

However, some difficulties exist in studying those new phases due to the complexity of their structures and lack of fundamental experimental data including the material constants to date. Furthermore, the theoretical studies are also difficult. For example, the symmetry groups of soft-matter quasicrystals observed or possibly to be observed have not yet been well investigated although there are some work
being done (the details are not be included in the book). In conjunction with this issue, the study on constitutive laws for phasons and phonon–phason coupling are still difficult.

In spite of these problems, there are potential efforts to undertake the study on these topics. For example, the soft-matter quasicrystals as a new ordered phase are connected with broken symmetry or symmetry breaking, like those discussed in solid quasicrystals. Thus, the elementary excitations such as phonons and phasons are important issues in the study of quasicrystals based on the Landau phenomenological theory. For soft-matter quasicrystals, furthermore, another elementary excitation, i.e. the fluid phonon must be considered besides phonons and phasons. According to the Landau school, liquid acoustic wave is fluid phonon (refer to Lifshitz EM and Pitaevskii LP, *Statistical Physics, Part 2*, Oxford: Butterworth-Heinemann, 1980). This is suitable for describing the liquid effect of soft-matter quasicrystals, which can be seen as complex liquids or structured liquids. The elementary excitations—phonons, phasons and fluid phonon—and their interactions constitute the main feature of the new phase. They will be discussed as a major issue in the book. The concept of the fluid phonon is introduced in the study of quasicrystals for the first time. Related to this, the equation of state should also be introduced. With these two key points and referencing the hydrodynamics of solid quasicrystals the dynamics of Soft Matter quasicrystals can be established, but with an important distinction compared with that of solid quasicrystals. The present hydrodynamics cannot be linearized due to the nonlinearity of equation of state. To overcome the difficulty arising from other aspects in theory, we can draw from study of solid quasicrystals (For example, Lubensky TC, *Symmetry, elasticity and hydrodynamics in quasiperiodic structures*, in Introduction to Quasicrystals, ed by Jaric M V, Boston: Academic Press, 199–289, 1988; Hu CZ et al, *Symmetry groups, physical property tensors, elasticity and dislocations in quasicrystals*, Rep. Prog. Phys., 63(1), 1-39, 2000; Fan TY, *Mathematical Theory of Elasticity of Quasicrystals and Its Applications*, Beijing: Science Press/Heidelberg: Springer-Verlag, 1st edition, 2010, 2nd edition, 2016). This shows that the theory of solid quasicrystals is a basis for the present discussion, which provides an initial glimpse from the viewpoint of quantitative analysis to the rich phenomena of soft-matter quasicrystals.

Some applications are given by describing the matter distribution, deformation and motion of soft-matter quasicrystals. The mathematical principle and its applications require the assistance of other areas of knowledge, a part of which is briefly listed in the first six chapters of the book (more details can refer to Chaikin J and Lubensky TC, *Principles of Condensed Matter Physics*, New York: Oxford University Press, 1995), and the others are introduced in due the computation. The computational results are preliminary and very limited so far, but verified partially the mathematical model, and explored in certain degree to distinguish the dynamic behaviour between soft-matter and solid quasicrystals to some extent. In addition, the specimens and flow modes adopted in the computation might be intuitive, observable and verified easily. However, it does not mean that they belong to the most important samples.
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