

## Exercises 25.02.2025 b - Symmetry

**1** In a material of the CsCl-structure (Fig.1.1), a phase transition occurs, which leads to a vertical displacement of the central atom of the unit cell along a 4-fold axis (Fig.1.2). Find the symmetry of the resulting phase.

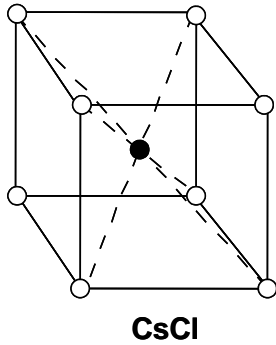


Fig.1.1

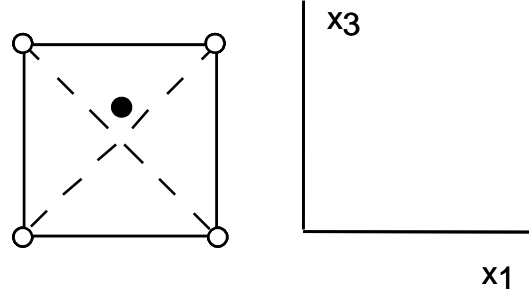
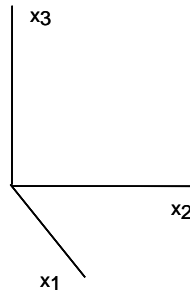
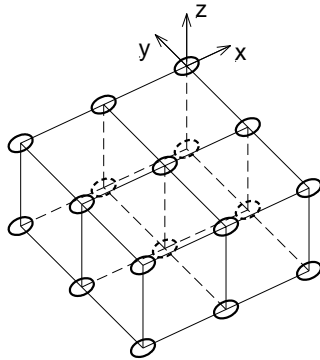


Fig.1.2

**2.** Find the point group symmetry of the following structure. The ovals are flat and lie in the (XY)-plane. The fundamental translation vectors are  $(a,0,0)$ ,  $(0,a,0)$ , and  $(0,0,a)$ .



**3** Propose a phase transition which reduces the symmetry of CsCl structure (Fig.1.1) from cubic ( $m\bar{3}m$ ) to  $mmm$

**4** Modify the object shown in slide Lect.2-58 by adding/removing atoms to obtain an object with symmetry:

- (a) 4
- (b)  $\bar{4}$ .

**5** Modify the object shown in slide Lect.2-58 by stretching it and/or adding/removing atoms to obtain an object with symmetry:

- (a)  $mmm$
- (b) 222