The study of non-covalent interactions among the molecules is one of the significant areas in science. Many of the phenomena in our daily life happen due to the non-covalent intermolecular interactions like existence of water as liquid, recognition of drug molecules in our body, structure of proteins, etc.1 Among these interactions, the role of stronger ones has already been established, while the weaker ones are still debatable, especially those involving ‘organic fluorine’.2 The impact of organic fluorine in the crystal packing of halogen substituted N-benzylideneaniline has been established earlier by some of us.3 Interactions involving F (C-H•••F, C-F•••F-C and C-F•••π) were identified and analysed purely from geometrical point of view. Further, these systems so far we studied were based on the spherical atom model and it was observed that mainly C-H•••F hydrogen bonds govern the crystal packing. In this approximation, electrons density of an atom is assumed to be spherical, which is a very good approximation for the heavier atoms. This is because in the heavier atoms the total electron density of an atom is dominated by core electrons. However, the electron densities of the lighter atoms (C, N, O, F) need not to be spherical. The effect of bonding is the most pronounced on the lightest atom, H, which has no inner shell and is the element of concern to study interactions involving such atoms. Charge density analysis, based on the aspherical modelling of the electron density, takes into account the bonding and lone pair electron densities of the atoms within the molecule. Use of this tool in conjunction with Bader’s quantum theory of atoms in molecules provides clear understanding of these weak interactions beyond mere geometry.

Herein, we intend to present our recent experimental and theoretical charge density analyses on a fluorinated compound (1-(2,3-difluorophenyl)-2-(3,4-difluorophenyl)-6-methoxy-1,2,3,4-tetrahydroisoquinoline) belonging to the class of isoquinolines to gain insights into C-H•••F-C, C-H•••O-C and type I C-F•••F-C interactions. The accuracy of the multipole model was checked through featureless plots of residual densities, presence of electron density in the bonding regions in the deformation density maps and also through Hirshfeld’s rigid bond test. The static deformation density and Laplacian maps obtained from both experimental and theoretical multipole refinements have been compared. The present work quantitatively evaluates the topological features associated with the C-H•••F-C, C-H•••O-C and type I C-F•••F-C interactions with a special insight into the hydrogen bond nature of C-H•••F-C. The first four essential criteria given by Koch and Popelier for hydrogen bond formation have been discussed in detailed.


Keywords: Charge Density Studies, Fluorine, Non-covalent interactions