Claims

1. A dielectric resonant structure for controlling harmonic distances, comprising a cavity, a support frame, a dielectric resonator and a cover plate, wherein the cavity is composed of a sealed space, and one surface of the cavity is a cover plate surface; the dielectric resonator is composed of a dielectric; the dielectric resonator is installed in the cavity and is not in contact with an inner wall of the cavity; the support frame is installed at any position between the dielectric resonator and the inner wall of the cavity, matches any shape of the dielectric resonator and the cavity, and is connected to, fixed with and support the dielectric resonator; the cavity is internally provided with a uniaxial cylindrical or polygonal dielectric resonator and the support frame fixed thereon, so as to form a multi-mode dielectric resonant structure with the cavity;

the dielectric resonator includes: a dielectric resonator composed of a single-axis cylinder or polygon;

or a dielectric resonator composed of two single-axis cylinders or polygons that are perpendicular to each other, wherein the X-axis dimension of the two perpendicular single-axis cylinders or polygons in the dielectric resonator is greater than or equal to the dimension in the vertical direction and parallel to the X-axis of the Y-axis; the Y-axis dimension of the two perpendicular cylinders or polygons in the dielectric resonator is greater than or equal to the dimension in the vertical direction and parallel to the Y-axis of the X-axis;

or a dielectric resonator composed of three single-axis cylinders or polygons that are perpendicular to each other, wherein the X-axis dimension of the three perpendicular single-axis cylinders or polygons in the dielectric resonator is greater than or equal to the dimensions in the vertical direction and parallel to the X-axis of the Y-axis and Z-axis; the Y-axis dimension of the three perpendicular single-axis cylinders or polygons in the dielectric resonator is greater than or equal to the dimensions in the vertical direction and parallel to the Y-axis of the X-axis and Z-axis; the Z-axis dimension of the three perpendicular single-axis cylinders or polygons in the dielectric resonator is greater than or equal to the dimensions in the vertical direction and parallel to the Z-axis of the X-axis and Y-axis, wherein the dielectric resonator is partially provided with a blind slot, a through slot, a blind hole or a through hole, or is provided with a protrusion on its surface; or, slots, holes or protrusions are symmetrically formed in the axial direction of the dielectric resonator; or, slots or holes are formed in any surface, edge or corner of the dielectric resonator; or, a protrusion is arranged on the surface of the dielectric resonator, and the dielectric resonator is partially provided with the blind slot, the through slot, the blind hole or the through hole, or is provided with the protrusion on its surface, so as to change the span of frequency between a fundamental mode and the span of frequency high-order mode or between the high-order mode and a higher-order mode.

2. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein slots or holes are formed in corners, edges, surfaces or interior of the dielectric resonator, and a plurality of slots or holes are symmetrically formed in different corners, edges and surfaces; or, a plurality of slots or holes are formed in the same surface; or, slots or holes are formed inside the dielectric resonator; or, slots or holes are symmetrically formed in different axial directions thereof.

3. The dielectric resonant structure for controlling harmonic distances according to claim 2, wherein the slots or holes are set as blind slots, blind holes, through slots or through holes, and under the condition that the frequency of the fundamental mode is kept unchanged, the dimension of the dielectric resonator changes after the slots and the holes are formed, so as to change the span of frequency between the fundamental mode and the high-order mode or between the high-order mode and the higher-order mode.

4. The dielectric resonant structure for controlling harmonic distances according to claim 2, wherein the protrusion is arranged at any position on any of the surfaces of the dielectric resonator, the protrusion is a cuboid, a cylinder or an irregular shape, and under the condition that the frequency of the fundamental mode is kept unchanged, the dimension of the dielectric resonator changes after the protrusion is arranged, so as to change the span of frequency between the fundamental mode and the high-order mode or between the high-order mode and the higher-order mode.

5. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein when dielectric resonator are trimmed, slotted and chamfered, the dimension of the inner wall of the cavity and the dimensions of three corresponding axial of dielectric resonator or the dimensions of horizontal and vertical directions of the dielectric resonators are changed , as a result the frequency of the fundamental mode and the frequency of multiple high-order modes, as well as the corresponding number of multi-modes of multiple high-order modes and Q values will been changed,

when the frequency of the fundamental mode is kept constant, the dielectric resonant structure for controlling harmonic distances, which is composed of dielectric resonators made of different dielectric materials, the cavity and the support frame, the multi-modes and the Q values corresponding to the frequency of the fundamental mode and the multiple high-order modes will change, the Q values of the dielectric resonators made of different dielectric materials will change differently, and meanwhile, the frequency of the high-order mode will also change.

6. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the cavity is internally provided with a uniaxial cylindrical or polygonal dielectric resonator and the support frame fixed thereon, so as to form a dielectric resonant structure for controlling harmonic

distances with the cavity and the cover plate, the center of an face of the dielectric resonator approaches to or coincides with a central position of a corresponding inner wall surface of the cavity, the horizontal and vertical dimensions of the dielectric resonator are trimmed, slotted and chamfered, so that the dimension of the inner wall of the cavity and the corresponding dimensions of the dielectric resonator in three axial directions are changed or dimensions in the horizontal and vertical directions of the dielectric resonator are changed, so as to change the frequency of the fundamental mode and the frequency of multiple high-order modes, as well as the corresponding number of multi-modes and Q values, when the X axis, Y axis and Z axis dimensions of the inner wall of the cavity change, and when at least one required frequency is kept unchanged, the X axis, Y axis and Z axis dimensions of the dielectric resonator corresponding to the inner wall of the cavity will also change accordingly;

or the cavity is internally provided with two vertically intersecting cylindrical or polygonal uniaxial dielectric resonators and the support frame fixed thereon, so as to form a dielectric resonant structure for controlling harmonic distances with the cavity and the cover plate, the center of the face of the dielectric resonator approaches to or coincides with the central position of the corresponding inner wall surface of the cavity, wherein the X axis dimension of the two vertically intersecting cylindrical or polygonal uniaxial dielectric resonators is greater than or equal to the dimension in the vertical direction and parallel to the X axis of the other cylindrical or polygonal uniaxial dielectric resonator; the Y axis dimension of the two vertically intersecting cylindrical or polygonal uniaxial dielectric resonators is greater than or equal to the dimension in the vertical direction and parallel to the Y axis of the other cylindrical or polygonal uniaxial dielectric resonator; the horizontal and vertical dimensions of the dielectric resonator are trimmed, slotted and chamfered, so that the dimension of the inner wall of the cavity and the corresponding dimensions of the dielectric resonator in three axial directions are changed or dimensions in the horizontal and vertical directions of the dielectric resonator are changed, so as to change the frequency of the fundamental mode and the frequency of multiple high-order modes, as well as the corresponding number of multi-modes and the Q values, when the X axis, Y axis and Z axis dimensions of the inner wall of the cavity change, and when a required frequency is kept unchanged, the X axis, Y axis and Z axis dimensions of the dielectric resonator corresponding to the inner wall of the cavity will also change accordingly;

or the cavity is internally provided with three vertically intersecting cylindrical or polygonal uniaxial dielectric resonators and the support frame fixed thereon, so as to form a dielectric resonant structure for controlling harmonic distances with the cavity and the cover plate, the center of the face of the dielectric resonator approaches to or coincides with the central position of the corresponding inner wall surface of the cavity, wherein the X axis dimension of the three vertically intersecting cylindrical

or polygonal uniaxial dielectric resonators is greater than or equal to the dimensions in the vertical direction and parallel to the X axis of the other two cylindrical or polygonal uniaxial dielectric resonators; the Y axis dimension of the three vertically intersecting cylindrical or polygonal uniaxial dielectric resonators is greater than or equal to the dimensions in the vertical direction and parallel to the Y axis of the other two cylindrical or polygonal uniaxial dielectric resonators; the Z axis dimension of the three vertically intersecting cylindrical or polygonal uniaxial dielectric resonators is greater than the dimensions in the vertical direction and parallel to the Z axis of the other two cylindrical or polygonal uniaxial dielectric resonators; and the horizontal and vertical dimensions of the dielectric resonator are trimmed, slotted and chamfered, so that the dimension of the inner wall of the cavity and the corresponding dimensions of the dielectric resonator in three axial directions are changed or dimensions in the horizontal and vertical directions of the dielectric resonator are changed, so as to change the frequency of the fundamental mode and the frequency of multiple high-order modes, as well as the corresponding number of multi-modes and the Q values, when the X axis, Y axis and Z axis dimensions of the inner wall of the cavity change, and when a required frequency is kept unchanged, the X axis, Y axis and Z axis dimensions of the dielectric resonator corresponding to the inner wall of the cavity will also change accordingly.

7. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the dielectric resonator is partially provided with slots or holes, wherein when the slots or holes are formed in an electric field dispersion area of an adjacent high-order mode, and the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is less than the span of frequency when the slots or holes are formed in an electric field concentration area; when the slots or holes are formed in the electric field concentration area of the adjacent high-order mode, and the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is greater than the span of frequency when the slots or holes are formed in the electric field dispersion area; and

the dielectric resonator is partially provided with slots or holes, and if the volume occupied by the slots or holes is small, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is small; if the volume occupied by the slots or holes is large, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is large; if the number of the slots or holes is small, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is small; and if the number of

the slots or holes is large, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is large.

8. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the dielectric resonator is partially provided with protrusions, when the protrusions are arranged in the electric field dispersion area of the high-order mode, and the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is greater than the span of frequency when the protrusions are arranged in the electric field concentration area; when the protrusions are arranged in the electric field concentration area of the high-order mode, and the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is less than the span of frequency when the protrusions are arranged in the electric field dispersion area; and

the dielectric resonator is partially provided with the protrusions, and if the volume occupied by the area of the protrusions is small, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is small; and if the volume occupied by the area of the protrusions is large, the span of frequency between the fundamental mode and the adjacent high-order mode or the span of frequency between the high-order mode and the higher-order mode is large.

9. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein:

when the dimension of the inner wall of the cavity and the corresponding dimensions of the dielectric resonator in three axial directions are changed or dimensions in the horizontal and vertical directions of the dielectric resonator are changed, the multi-modes and the Q values corresponding to the frequency of the fundamental mode and the frequency of multiple high-order modes will change, the Q values of the dielectric resonators with different dielectric constants will change differently, when the frequency of the fundamental mode is kept unchanged, the span of frequency between the high-order mode and the fundamental mode, and the span of frequency between the high-order mode and the higher-order mode will change multiple times, the span of frequency of the dielectric resonators with different dielectric constants also change differently,

wherein the size of the Q value changes when the ratios of the dimension of the inner wall of the cavity to the corresponding dimensions of the dielectric resonator in three axial directions or the horizontal and vertical dimensions are certain ratios, the size of the Q value is proportional to a

change in the size of the dimension ratio, or the size of the Q value is proportional to the change in the size of the dimension ratio and the Q value has greater changes in the vicinity of several certain specific ratios, the multi-mode Q values corresponding to different frequencies change differently in the vicinity of the several certain specific ratios,

when the dimension of the cavity and the frequency of the fundamental mode are kept unchanged, and when the horizontal and vertical dimensions of the three axial dimensions of the uniaxial dielectric resonator are arbitrarily combined for change, the fundamental mode of the uniaxial dielectric resonant structure can form 1-3 multi-modes with the same frequency or similar frequency, and multiple high-order modes with different frequencies form 1-N multi-modes under the same frequency; and the fundamental mode of a vertically intersecting biaxial dielectric resonator structure or vertically intersecting triaxial dielectric resonator structure can form 2-6 multi-modes with the same frequency or similar frequency, multiple high-order modes with different frequencies form 1-N multi-modes under the same frequency, and

when the dimensions of the cavity corresponding to the three axial dimensions of the dielectric resonator change, the corresponding the span of frequency between the fundamental mode and the high-order mode or the span of frequency between the high-order mode and the higher-order mode, the Q value and the modulus will also change accordingly.

10. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein edges or sharp corners of the cavity or/and the dielectric resonator are trimmed to form adjacent coupling, the cavity and the dielectric resonator are cut into triangles or quadrilaterals, or the edges of the cavity or the dielectric resonator are partially or completely cut off, the cavity and the dielectric resonator are trimmed at the same time or separately, after the adjacent coupling is formed by trimming, the frequency and the Q value will change correspondingly, the adjacent coupling changes its cross coupling,

a sharp corner position at the intersection of three surfaces of the cavity corresponding to the dielectric resonator is chamfered or is chamfered with the cavity and closed to form cross coupling, and the corresponding frequency and the Q value will also change correspondingly, the adjacent coupling will be changed at the same time, and

when the dielectric resonator is provided with the slots or holes or protrusions at the corners and edges, the strength of the adjacent coupling and the cross coupling will be changed.

11. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein

the shape of the cavity comprises, but is not limited to, a cuboid, a cube and a polygon, the inner wall surface or an inner area of the cavity can be partially provided with a depression or a protrusion or a cut corner or a slot, at least one tuning device is arranged at a field strength concentration position of the dielectric resonator and is installed on the cavity, the material of the cavity is metal or non-metal, and the surface of the space is electroplated with copper or silver.

12. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the cross-sectional shape of the dielectric resonator in any axial direction comprises a circle, an ellipse, and a polygon;

slots or holes are formed in the corners, edges or surfaces of the dielectric resonator; or, a plurality of slots or holes are symmetrically formed in different corners, edges and surfaces; or, a plurality of slots or holes are formed in the same surface; or, slots or holes are formed inside the dielectric resonator; or, slots or holes are symmetrically formed in different axial directions of the dielectric resonator; or, a plurality of slots or holes are formed in the same surface; or, protrusions are arranged on the surface of the dielectric resonator; or, different numbers of protrusions of a cylindrical or a polygonal are arranged at any position on any surface of the dielectric resonator;

the dielectric resonator is solid or hollow,

the dielectric resonator is made of ceramics, a composite dielectric material or a dielectric material with a dielectric constant greater than 1, and

different shapes, different materials and different dielectric constants of the dielectric resonator will also affect the span of frequency between the fundamental mode and the high-order mode or the span of frequency between the high-order mode and higher-order mode.

13. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the support frame is located at the face, edge or sharp corner of the dielectric resonator or at the sharp corner of the cavity, and is arranged between the dielectric resonator and the cavity, the dielectric resonator is supported by the support frame in the cavity,

the support frame and the dielectric resonator or the cavity are combined to form an integrated structure or a split structure,

the support frame is made of a dielectric material, and the material of the support frame is plastic, ceramic or a composite dielectric material,

when the support frame is installed on different positions of the dielectric resonator, the

corresponding the span of frequency between the fundamental mode and the high-order mode or the span of frequency between the high-order mode and the higher-order mode will also be different, and

different materials of the support frame, different dielectric constants and different structures will also affect the span of frequency between the fundamental mode and the high-order mode or the span of frequency between the high-order mode and the higher-order mode.

14. The dielectric resonant structure for controlling harmonic distances according to claim 13, wherein the support frame is connected to the dielectric resonator and the cavity by means of crimping, bonding, splicing, welding, buckling or screw connection, the support frame is connected to one or more faces of the uniaxial dielectric resonator or the vertically intersecting uniaxial dielectric resonators or the three vertically intersecting uniaxial dielectric resonators,

the dielectric resonator is formed by fixing small dielectric resonant blocks after cutting using a dielectric or metal connecting block by means of crimping, bonding, splicing, welding, buckling or screw connection; and

the support frame is installed at any position between the dielectric resonator and the inner wall of the cavity, matches any shape of the dielectric resonator and the cavity, and is connected and fixed, the support frame comprises a solid body with two parallel sides or a structure with a penetrated middle, the number of support frames on the same face or different faces, edges or sharp corners of the dielectric resonator is one or multiple different combinations, and different numbers of support frames have the different span of frequency between the fundamental mode and the high-order mode or between the high-order mode and the higher-order mode.

15. The dielectric resonant structure for controlling harmonic distances according to claim 1, wherein the support frame of the dielectric resonator is in contact with the inner wall of the cavity to form heat conduction.

16. A dielectric filter comprising the dielectric resonant structure for controlling harmonic distances according to any of claims 1-15, wherein one of the dielectric resonant structures for controlling harmonic distances can form 1-N single-passband filters with different frequencies, where N is a natural number greater than 1, the single-passband filters with different frequencies can be combined to form multi-passband filters, duplexers or multiplexers, and the corresponding dielectric resonant structure for controlling harmonic distances can also be combined with metal or dielectric single-mode resonant cavities, dual-mode resonant cavities and triple-mode resonant cavities in various

forms to form multiple single-passband or multi-passband filters or duplexers or multiplexers with different dimensions,.

17. The dielectric filter according to claim 16, wherein the cavity of one of the dielectric resonant structures for controlling harmonic distances may be combined with a single-mode or multi-mode cavity of a metal resonator or a dielectric resonator to form combinations of adjacent coupling or cross coupling,.