CLAIMS

1. A method of imaging comprising:

generating a superoscillatory field from coherent electromagnetic radiation;

placing an object in the superoscillatory field;

detecting one or more intensity distributions of the superoscillatory field scattered by the object; and

determining at least one characteristic of the object from the one or more intensity distributions;

in which generating the superoscillatory field comprises passing the coherent electromagnetic radiation through a nanostructured metasurface; and

in which the nanostructured metasurface is configured to generate an interferometric superoscillatory field comprising interference between a plane wave and a superoscillatory field.

2. A method according to claim 1, in which the coherent electromagnetic radiation is optical radiation, and the object is dimensioned on the nanoscale.

3. A method according to claim 1 or claim 2, in which the determining comprises providing the one or more intensity distributions to a neural network trained with intensity distributions of the superoscillatory field scattered by other objects, and allowing the neural network to deduce one or more characteristics of the object.

4. A method according to claim 3, in which the detecting comprises detecting a plurality of intensity distributions corresponding to different positions of the object in the superoscillatory field.

5. A method according to claim 3 or claim 4, further comprising, prior to the placing:

positioning a first object with one or more known characteristics in the superoscillatory field;

recording at least one intensity distribution of the superoscillatory field scattered by the first object;

repeating the positioning and recording for a plurality of further objects with known characteristics;

providing the recorded intensity distributions to a neural network; and

training the neural network to deduce characteristics of an unknown object using the recorded intensity distributions.

6. A method according to claim 3 or claim 4, further comprising, prior to the placing:

generating by computer processing a plurality of intensity distributions of the superoscillatory field scattered by plurality of computer-generated objects with known characteristics;

providing the computer-generated intensity distributions to a neural network; and

training the neural network to deduce characteristics of an unknown object using the computer-generated intensity distributions.

7. A method according to claim 1 or claim 2, in which:

the detecting comprises:

detecting at a first position relative to the object a plurality of intensity distributions of the superoscillatory field scattered by the object, each intensity distribution being for a different polarisation state of the coherent electromagnetic radiation; and

optionally detecting further corresponding pluralities of intensity distributions at further positions relative to the object, such that the first position and the further positions lie on a closed or open curve or surface around the object;

and

the determining comprises:

retrieving a phase distribution of the superoscillatory field at each of the first position and any further positions from the plurality of intensity distributions at that position; and

using the intensity distributions and the phase distributions to determine a reconstruction of at least part of the object by backward wave propagation.

8. A method according to claim 7, in which the different polarisation states comprise a left circular polarisation, a right circular polarisation, and two orthogonal linear polarisations.

9. A method according to any preceding claim, in which the at least one characteristic of the object comprises one or more of size, shape, orientation, position, movement, appearance, composition, spacing, presence or absence of a defect, position of a defect, a number of particles comprised in the object, a type of particle comprised in the object, and a material from which the object is made.

10. An apparatus configured to implement a method according to any one of claims 1 to 9.

11. An apparatus for imaging an object comprising:

a superoscillatory field generator configured to generate a superoscillatory field;

a detector configured to detect an intensity distribution of the superoscillatory field; and

a processor configured to receive intensity distributions, detected by the detector, of the superoscillatory field scattered by an object placed in the superoscillatory field, and determine at least one characteristic of the object from one or more of the intensity distributions;

in which the superoscillatory field generator comprises an optical source operable to output a beam of coherent optical radiation, and a nanostructured metasurface through which the beam of coherent optical radiation is passed in order to generate a superoscillatory field; and

in which the nanostructured metasurface is configured to generate an interferometric superoscillatory field comprising interference between a plane wave and a superoscillatory field.

12. An apparatus according to claim 11, in which the processor is comprised in a computer system storing a neural network trained with intensity distributions of the superoscillatory field scattered by other objects and operable to deduce one or more characteristics of the object.

13. An apparatus according to claim 11, in which:

the superoscillatory field generator comprises a polarisation controller configured to select a polarisation state of coherent electromagnetic radiation from which the superoscillatory field is generated; and

the processor is further configured to retrieve a phase distribution of the scattered superoscillatory field from a plurality of intensity distributions detected for different polarisation states, and to determine the at least one characteristic by using intensity distributions and phase distributions for at least one position on a closed or open curve or surface around an object in the superoscillatory field in backward wave propagation calculations.

14. A computer program, or storage medium storing software comprising a computer program, configured to:

receive, for one or more positions of an object placed in a superoscillatory field, a plurality of detected intensity distributions of the superoscillatory field scattered by the object, each intensity distribution being for a different polarisation state of coherent electromagnetic radiation from which the superoscillatory field is generated, the superoscillatory field having being generated by passing

the coherent electromagnetic radiation through a nanostructured metasurface configured to generate an interferometric superoscillatory field comprising interference between a plane wave and a superoscillatory field;

retrieve a phase distribution of the scattered superoscillatory field from the or each plurality of detected intensity distributions; and

determine a reconstruction of at least part of the object from the detected intensity distributions and retrieved phase distributions.