CLAIMS

1. A spectrometer for detecting an electromagnetic (EM) wave spectrum having one or more wavelength components within a spectral band of interest, comprising:

an entrance aperture;

a dispersion and imaging optics containing at least one dispersion element;

an exit aperture;

a collection optics; and

at least one single-pixel detector, each single-pixel detector sensitive to one or more of the wavelength components;

wherein the entrance aperture comprises at least one entrance slit that is spatially encoded along a direction substantially transverse to a direction of dispersion of the dispersion and imaging optics;

wherein the dispersion and imaging optics is configured to create dispersed images of the entrance aperture on a plane of the exit aperture, such that respective images at the different wavelength components are offset by different amounts of displacements along the direction of dispersion;

wherein the exit aperture comprises a plurality of exit slits arranged in the direction of dispersion, wherein each exit slit is spatially encoded along the direction substantially transverse to the direction of dispersion;

wherein the collection optics is configured to gather a total EM wave energy that enters the entrance aperture and exits the exit aperture to one of the at least one single-pixel detectors;

wherein at least one of an encoding pattern of the at least one entrance slits and an encoding pattern of the plurality of exit slits is adjustable and configured to be changed for a number of times;

the spectrometer further comprising a measurement unit configured to measure the output of the at least one detector for respective ones of the number of times for reconstructing the EM wave spectrum; and

wherein the spectrometer is configured such that an image width of a single one of the entrance slits at a single wavelength component is smaller than a spot size of the spectrometer at the exit aperture such that a spectral resolution of the spectrometer is independent of the number of single entrance slits comprised in the entrance aperture.

2. The spectrometer of claim 1, wherein the adjustable encoding pattern of the at least one entrance slits and/or of the plurality of exit slits is implemented using microelectromechanical systems (MEMS) technology.

3. The spectrometer of claim 2, wherein the adjustable encoding pattern of the at least one entrance slits and/or of the plurality of exit slits is implemented using MEMS micromirror arrays.

4. The spectrometer of claim 1, wherein the adjustable encoding pattern of the at least one entrance slits and/or of the plurality of exit slits is implemented using a movable mask placed in the vicinity of a fix aperture opening.

5. The spectrometer of claim 4, wherein the movable mask is moveable along a preferred direction, and the preferred direction is along the direction of dispersion or perpendicular to the direction of dispersion.

6. The spectrometer of claims 4 or 5, wherein the movable mask is suspended by springs, and the mask is configured to be driven into an oscillatory motion at its natural frequency to gain the advantage of high-speed and large area encoding.

7. The spectrometer of any one of the preceding claims, wherein the dispersion and imaging optics and the collection optics is configured to share, in part or in whole, same optics elements.

8. The spectrometer of claim 7, wherein the encoding pattern of the plurality of exit slits is configured to be operated in a reflection mode.

9. The spectrometer of any one of the preceding claims, wherein the collection optics comprises imaging collection optics forming an image of the at least one dispersion element on a photosensitive area of the at least one single-pixel detector.

10. The spectrometer of claim 9, wherein the spectrometer comprises a first field lens placed adjacent the exit aperture to decrease the image of the at least one dispersion element on the photosensitive area of the at least one single-pixel detector.

11. The spectrometer of any one of the preceding claims, wherein the spectrometer further comprises a second field lens placed adjacent the entrance aperture to image an exit pupil of preceding optics onto the at least one dispersion element.

12. The spectrometer of any one of claims 1 to 6, wherein the spectrometer comprises non-imaging collection optics such as a concentrator concentrating light from the exit aperture onto a photosensitive area of the at least one single-pixel detector.

13. The spectrometer of claim 12, wherein the non-imaging collection optics comprises a plurality of concentrators, each concentrating a portion of the light from the exit aperture onto a photosensitive area of respective one of a plurality of detectors.

14. The spectrometer of any one of the preceding claims, wherein encoding pixels for at least the exit aperture are configured to match distorted images of the slits of the entrance aperture.

15. The spectrometer of any one of the preceding claims, wherein the entrance aperture comprises a plurality of entrance slits with no gaps or with narrow, non-zero gaps therebetween.

16. The spectrometer of any one of the preceding claims, wherein the exit aperture comprises a plurality of exit slits with no gaps or with narrow, non-zero gaps therebetween.

17. A method of detecting an electromagnetic (EM) wave spectrum having one or more wavelength components within a spectral band of interest, using:

an entrance aperture;

a dispersion and imaging optics containing at least one dispersion element;

an exit aperture;

a collection optics; and

at least one single-pixel detector, each single-pixel detector sensitive to one or more of the wavelength components;

the method comprising the steps of:

spatially encoding at least one entrance slit of the entrance aperture along a direction substantially transverse to a direction of dispersion of the dispersion and imaging optics;

creating, using the dispersion and imaging optics, dispersed images of the entrance aperture on a plane of the exit aperture, such that respective images at the different wavelength components are offset by different amounts of displacements along the direction of dispersion;

spatially encoding a plurality of exit slits of the exit aperture along the direction substantially transverse to the direction of dispersion, wherein the exit aperture comprises a plurality of exit slits arranged in the direction of dispersion;

gathering, using the collection optics, a total EM wave energy that enters the entrance aperture and exits the exit aperture to one of the at least one single-pixel detectors, wherein an image width of a single one of the entrance slits is at a single wavelength component smaller than a spot size of the spectrometer at the exit aperture such that a spectral resolution of the spectrometer is independent of the number of single entrance slits comprised in the entrance aperture;

changing at least one of an encoding pattern of the at least one entrance slits and an encoding pattern of the plurality of exit slits for a number of times; and

measuring the output of the at least one detector for respective ones of the number of times for reconstructing the EM wave spectrum.