

WHAT IS CLAIMED IS:

1. A method for operating a symmetrical multistatic constellation of at least four satellites to generate a set of Earth observations comprising:
 - transmitting a set of at least four sounding signals from the constellation towards the Earth, wherein each satellite in the constellation individually generates at least one sounding signal in the set of sounding signals;
 - detecting a set of at least four forward scatter signals from the Earth using the constellation, wherein:
 - the signals in the set of forward scatter signals uniquely correspond with the signals in the set of sounding signals to form a set of sounding pairs; and
 - the signals in each sounding pair in the set of sounding pairs are transmitted and received by different satellites in the constellation;
 - analyzing, using a set of at least four signal analyzers, the set of at least four forward scatter signals to obtain a set of data, wherein each satellite in the constellation individually houses a signal analyzer in the set of at least four signal analyzers; and
 - deriving the set of Earth observations using the set of data.
2. The method of claim 1, wherein:
 - the set of data includes the phase, amplitude, delay, frequency and polarization of the set of forward scatter signals; and
 - the deriving includes scatterometry derivations and altimetry derivations.
3. The method of claim 1, wherein:
 - each satellite in the constellation individually generates at least two time-gated sounding signals in the set of sounding signals;
 - each satellite in the constellation includes an oscillator, whereby the constellation includes a set of oscillators;
 - the transmitting and detecting steps are conducted using the set of oscillators; and
 - the deriving includes synthetic aperture radar derivations.
4. The method of claim 1, wherein:
 - each satellite in the constellation individually generates at least two sets of time-gated sounding signals in the set of sounding signals;
 - each satellite in the constellation includes an oscillator, whereby the constellation includes a set of oscillators;

the transmitting and detecting steps are conducted using the set of oscillators; and
the deriving includes interferometric synthetic aperture radar derivations.

5. The method of claim 1, wherein:

each signal in the set of sounding signals is encoded using a unique PN code from a set of PN codes; and

the signal analyzers in the set of signal analyzers are PN-code signal analyzers.

6. The method of claim 1, further comprising:

detecting a set of at least four back scatter signals from the Earth using the constellation, wherein the signals in the set of back scatter signals uniquely correspond with the signals in the set of sounding signals to form a set of monostatic sounding pairs.

7. The method of claim 6, further comprising:

spacing the constellation using a nonuniform lateral spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a set of reflection points on the Earth;

wherein the constellation includes a number of satellites;

wherein the set of sounding pairs has a set size equal to n^2 where n is the number of satellites in the constellation;

wherein the set of reflection points is greater than twice the number; and

wherein the set of reflection points has a uniform lateral spacing.

8. The method of claim 1, wherein:

the transmitting of the set of at least four sounding signals targets a single shared reflection point on the Earth; and

the transmitting of the set of at least four sounding signals is conducted at a single time using a set of at least four oscillators located on the set of at least four satellites.

9. The method of claim 8, wherein:

when the constellation transmits the set of at least four sounding signals, each satellite in the constellation shares a look angle relative to the single shared reflection point with every satellite in the constellation.

10. The method of claim 1, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, each satellite in the constellation is equidistant from the single shared reflection point.

11. The method of claim 1, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, a first subset of satellites in the constellation is equidistant from the reflection point according to a first distance;

wherein, when the constellation transmits the set of at least four sounding signals, a second subset of satellites in the set of satellites is equidistant from the reflection point according to a second distance; and

wherein the first and second distances are not equal.

12. The method of claim 1, further comprising:

spacing the constellation using a nonuniform axial spacing;

reflecting the set of at least four forward scatter signals from the Earth at a first single shared reflection point on the Earth;

shifting the nonuniform axial spacing; and

reflecting a second set of at least four forward scatter signals from the Earth as a second single shared reflection point on the Earth;

wherein the first single shared reflection point and the second single shared reflection point are laterally shifted across the constellation.

13. The method of claim 1, wherein detecting the set of at least four forward scatter signals from the Earth using the constellation further comprises:

gating a time delay for the set of four forward scatter signals using a set of oscillators; and

gating a frequency shift for the set of four forward scatter signals; and

wherein each satellite in the constellation includes an oscillator in the set of oscillators.

14. The method of claim 1, wherein the Earth Observations comprise:

relative topography, surface wind speed and direction, and absolute altitude.

15. A method for operating a constellation of at least four satellites to generate a set of Earth observations comprising:

transmitting a set of sounding signals from the constellation towards the Earth, wherein each satellite in the constellation individually generates at least one sounding signal in the set of sounding signals;

detecting a set of forward scatter signals from the Earth using the constellation, wherein:

the signals in the set of forward scatter signals uniquely correspond with the signals in the set of sounding signals to form a set of sounding pairs; and

the signals in each sounding pair in the set of sounding pairs are transmitted and received by different satellites in the constellation;

analyzing, using a set of signal analyzers, the set of forward scatter signals to obtain a set of data, wherein each satellite in the constellation individually houses a signal analyzer in the set of signal analyzers; and

deriving the set of Earth observations using the set of data

wherein the analyzing step is conducted using a number of forward scatter signals equal to $n(n-1)$ where n is the number of satellites in the constellation.

16. The method of claim 15, wherein:

the set of data includes the phase, amplitude, delay, frequency and polarization of the set of forward scatter signals; and

the deriving includes scatterometry derivations and altimetry derivations.

17. The method of claim 15, wherein:

each satellite in the constellation individually generates at least two sets of time-gated sounding signals in the set of sounding signals;

each satellite in the constellation includes an oscillator, whereby the constellation includes a set of oscillators;

the transmitting and detecting steps are conducted using the set of oscillators; and

the deriving includes interferometric synthetic aperture radar derivations.

18. The method of claim 15, wherein:

each signal in the set of sounding signals is encoded using a unique PN code from a set of PN codes; and

the signal analyzers in the set of signal analyzers are PN-code signal analyzers.

19. The method of claim 15, wherein:

the transmitting of the set of at least four sounding signals targets a single shared reflection point on the Earth; and

the transmitting of the set of at least four sounding signals is conducted at a single time using a set of at least four oscillators located on the set of at least four satellites.

wherein when the constellation transmits the set of at least four sounding signals, each satellite in the constellation shares a look angle relative to the single shared reflection point with every satellite in the constellation.

20. The method of claim 15, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, each satellite in the constellation is equidistant from the single shared reflection point.

21. The method of claim 15, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, a first subset of satellites in the constellation is equidistant from the reflection point according to a first distance;

wherein, when the constellation transmits the set of at least four sounding signals, a second subset of satellites in the set of satellites is equidistant from the reflection point according to a second distance; and

wherein the first and second distances are not equal.

22. The method of claim 15, further comprising:

spacing the constellation using a nonuniform axial spacing;

reflecting the set of at least four forward scatter signals from the Earth at a first single shared reflection point on the Earth;

shifting the nonuniform axial spacing; and

reflecting a second set of at least four forward scatter signals from the Earth as a second single shared reflection point on the Earth;

wherein the first single shared reflection point and the second single shared reflection point are laterally shifted across the constellation.

23. The method of claim 15, wherein detecting the set of at least four forward scatter signals from the Earth using the constellation further comprises:

gating a time delay for the set of four forward scatter signals using a set of oscillators; and

gating a frequency shift for the set of four forward scatter signals; and

wherein each satellite in the constellation includes an oscillator in the set of oscillators.

24. A method for operating a constellation of at least four satellites to generate a set of Earth observations comprising:

transmitting a set of at least four signals towards the Earth using the constellation;

receiving, after transmitting the set of at least four signals, a set of at least four reflected signals from the Earth using the constellation, wherein the set of at least four reflected signals are the set of at least four signals after having been reflected from the Earth;

analyzing, after receiving the set of at least four signals, and using a set of at least four signal analyzers, the set of at least four signals to generate a set of data, wherein each satellite in the constellation individually houses a signal analyzer in the set of at least four signal analyzers; and

deriving the set of Earth observations using the set of data;

wherein each satellite receives a signal in the set of at least four signals from every other satellite in the constellation.

25. The method of claim 24, wherein:

the set of data includes the phase, amplitude, delay, frequency and polarization of the set of forward scatter signals; and

the deriving includes scatterometry derivations and altimetry derivations.

26. The method of claim 24, wherein:

each satellite in the constellation individually generates at least two sets of time-gated sounding signals in the set of sounding signals;

each satellite in the constellation includes an oscillator, whereby the constellation includes a set of oscillators;

the transmitting and detecting steps are conducted using the set of oscillators; and

the deriving includes interferometric synthetic aperture radar derivations.

27. The method of claim 24, wherein:

each signal in the set of sounding signals is encoded using a unique PN code from a set of PN codes; and

the signal analyzers in the set of signal analyzers are PN-code signal analyzers.

28. The method of claim 24, wherein:

the transmitting of the set of at least four sounding signals targets a single shared reflection point on the Earth; and

the transmitting of the set of at least four sounding signals is conducted at a single time using a set of at least four oscillators located on the set of at least four satellites.

wherein when the constellation transmits the set of at least four sounding signals, each satellite in the constellation shares a look angle relative to the single shared reflection point with every satellite in the constellation.

29. The method of claim 24, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, each satellite in the constellation is equidistant from the single shared reflection point.

30. The method of claim 24, further comprising:

spacing the constellation using a nonuniform axial spacing; and

reflecting the set of at least four forward scatter signals from the Earth at a single shared reflection point on the Earth;

wherein, when the constellation transmits the set of at least four sounding signals, a first subset of satellites in the constellation is equidistant from the reflection point according to a first distance;

wherein, when the constellation transmits the set of at least four sounding signals, a second subset of satellites in the set of satellites is equidistant from the reflection point according to a second distance; and

wherein the first and second distances are not equal.

31. The method of claim 24, further comprising:

spacing the constellation using a nonuniform axial spacing;

reflecting the set of at least four forward scatter signals from the Earth at a first single shared reflection point on the Earth;

shifting the nonuniform axial spacing; and

reflecting a second set of at least four forward scatter signals from the Earth as a second single shared reflection point on the Earth;

wherein the first single shared reflection point and the second single shared reflection point are laterally shifted across the constellation.

32. The method of claim 24, wherein detecting the set of at least four forward scatter

signals from the Earth using the constellation further comprises:

gating a time delay for the set of four forward scatter signals using a set of oscillators; and

gating a frequency shift for the set of four forward scatter signals; and

wherein each satellite in the constellation includes an oscillator in the set of oscillators.