CLAIMS

1. A method of identifying proteins in a sample, comprising:

(a) incubating a particle panel, comprising a plurality of superparamagnetic iron oxide nanoparticles (SPIONs) with distinct surface chemistries, with the sample to form a plurality of distinct biomolecule coronas corresponding to distinct SPION types of the particle panel;

(b) magnetically isolating the particle panel from unbound protein in the sample to enrich proteins in the plurality of distinct biomolecule coronas; and

(c) assaying the plurality of distinct biomolecule coronas to identify at least 500 unique proteins from the enriched proteins**.**

2. The method of claim 1, wherein the assaying identifies from 500 to 20,000 unique proteins from the enriched proteins.

3. The method of claim 1 or 2, wherein the assaying identifies from 1,000 to 5,000 unique proteins from the enriched proteins.

4. The method of any one of claims 1-3, wherein the assaying identifies from 1,200 to 2,200 unique proteins from the enriched proteins.

5. The method of any one of claims 1-4, wherein an individual protein of the unique proteins comprises a peptide sequence having a minimum length of 7 amino acid residues.

6. The method of any one of claims 1-5, wherein the assaying comprises using mass spectrometry to identify the unique proteins in the sample.

7. The method of any one of claims 1-6, wherein the sample comprises a plurality of samples.

8. The method of claim 7, wherein the plurality of samples comprises at least two or more spatially isolated samples.

9. The method of claim 7 or 8, wherein the plurality of samples comprises at least 10 spatially isolated samples.

10. The method of claim 8 or 9, wherein the incubating comprises contacting the sample, which is provided in at least two or more spatially isolated samples with the particle panel at the same time, or wherein the magnetically isolating comprises magnetically isolating the particle panel from unbound protein in the at least two or more spatially isolated samples of the plurality of samples at the same time.

11. The method of any one of claims 1-10, further comprising repeating steps (a)-(c), wherein, when repeated, the incubating, isolating, and assaying yields a percent quantile normalized coefficient (QNCV) of variation of 20% or less, as determined by comparing a peptide mass spectrometry feature from at least three full-assay replicates for each particle type in the particle panel.

12. The method of any one of claims 1-11, wherein the assaying is capable of identifying proteins over a dynamic range of at least 7.

13. The method of any one of claims 1-12, further comprising washing the particle panel at least one time after the magnetically isolating the particle panel from the unbound protein.

14. The method of any one of claims 1-13, further comprising washing the particle panel at least two times after the magnetically isolating the particle panel from the unbound protein.

15. The method of any one of claims 1-14, further comprising, before the assaying of (c), (i) lysing the enriched proteins in the plurality of distinct biomolecule coronas, (ii) digesting the enriched proteins in the plurality of distinct biomolecule coronas to generate digested peptides, or (iii) purifying the digested peptides.

16. The method of claim 15, wherein the digesting the enriched proteins is performed in the presence of the plurality of SPIONs.

17. The method of claim 15 or 16, wherein the digesting is performed using a protease.

18. The method of any one of claims 1-17, wherein the assaying of (c) comprises using mass spectrometry to identify the unique proteins in the sample.

19. The method of any one of claims 1-18, wherein the assaying of (c) is performed in 2 to 4 hours.

20. The method of any one of claims 1-19, wherein the method is performed in 1 to 20 hours.

21. The method of any one of claims 1-20, wherein the isolating takes no more than 30 minutes.

22. The method of any one of claims 1-21, wherein the particle panel comprises at least 2 distinct SPION types.

23. The method of any one of claims 1-22, wherein the particle panel comprises a first distinct SPION type and a second distinct SPION type, wherein the first distinct SPION type and the second distinct SPION type share at least one physicochemical property and differ by at least one physicochemical property, such that the first distinct SPION type and the second distinct SPION type are different.

24. The method of any one of claims 1-23, wherein the particle panel comprises a first distinct SPION type, a second distinct SPION type, and a third distinct SPION type, wherein the first distinct SPION type, the second distinct SPION type, and the third distinct SPION type comprise iron oxide cores, polymer shells, and are less than 500 nm in diameter, and wherein the first distinct SPION type comprises a negative charge, the second distinct SPION type comprises a positive charge, and the third distinct SPION type comprises a neutral charge, wherein the diameter is a mean diameter as measured by dynamic light scattering.

25. The method of any one of claims 1-24, wherein at least two SPION types in the distinct SPION types of the particle panel differ by at least one surface chemical group.

26. The method of claim 25, wherein the first distinct SPION type comprises a silica coating, the second distinct SPION type comprises a poly(N-(3-(dimethylamino)propyl) methacrylamide) (PDMAPMA), and the third distinct SPION type comprises a poly(oligo(ethylene glycol) methyl ether methacrylate) (POEGMA) coating.

27. The method of any one of claims 1-26, wherein each SPION of the particle panel comprises an iron oxide material.

28. The method of any one of claims 1-27, wherein at least one distinct SPION type of the particle panel has an iron oxide core or a polystyrene core with iron oxide crystal embedded therein.

29. The method of any one of claims 1-28, wherein each distinct SPION type of the particle panel has an iron oxide core or a polystyrene core with iron oxide crystal embedded therein.

30. The method of any one of claims 1-29, wherein at least one distinct SPION type of the particle panel comprises a carboxylated polymer, an aminated polymer, a zwitterionic polymer, or any combination thereof.

31. The method of any one of claims 1-30, wherein at least one SPION type of the particle panel comprises an iron oxide core with a silica shell coating, an iron oxide core with a poly(N-(3-(dimethylamino)propyl) methacrylamide) (PDMAPMA) coating, or an iron oxide core with a poly(oligo(ethylene glycol) methyl ether methacrylate) (POEGMA) coating.

32. The method of any one of claims 1-31, wherein at least one distinct SPION type of the particle panel comprises a negative surface charge.

33. The method of any one of claims 1-32, wherein at least one distinct SPION type of the particle panel comprises a positive surface charge.

34. The method of any one of claims 1-33, wherein at least one distinct SPION type of the particle panel comprises a neutral surface charge.

35. The method of any one of claims 1-34, wherein the sample is a biological sample, and wherein the biological sample is plasma, serum, CSF, urine, tear, cell lysates, tissue lysates, cell homogenates, tissue homogenates, nipple aspirates, fecal samples, synovial fluid and whole blood, or saliva.

36. The method of claim 35, wherein the sample is plasma or serum.

37. The method of any one of claims 1-36, wherein the plurality of SPIONs comprise a heterogeneous size distribution.

38. The method of any one of claims 1-36, wherein the plurality of SPIONs comprise a homogeneous size distribution.

39. The method of any one of claims 1-38, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.5.

40. The method of claim 39, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.2.

41. The method of claim 40, wherein each distinct SPION type of the particle panel comprises a polydispersity index of less than 0.1.