What is claimed is:

**1**. A method of detecting a molecule of interest, the method comprising:

providing a first molecule covalently bonded to at least one magnetizable nanoparticle;

providing a second molecule covalently bonded to a substrate;

contacting the first molecule to the second molecule under conditions suitable for selective binding of the first molecule to the second molecule to form a complex; and

detecting the complex.

**2**. The method of claim 1, wherein the first molecule comprises a first nucleic acid molecule and the second molecule comprises a second nucleic acid molecule.

**3**. The method of claim 1, wherein the first molecule is DNA or RNA.

**4**. The method of claim 1, wherein the second molecule is DNA or RNA.

**5**. The method of claim 1, wherein the first molecule comprises a first protein molecule and the second molecule comprises a second protein molecule.

**6**. The method of claim 1, wherein the first molecule comprises a first peptide molecule and the second molecule comprises a second peptide molecule.

**7**. The method of claim 1, wherein the first molecule comprises an antigen molecule and the second molecule comprises an antibody molecule.

**8**. The method of claim 1, wherein the first molecule comprises an antibody molecule and the second molecule comprises an antigen molecule.

**9**. The method of claim 1, wherein the first molecule is covalently bonded to at least one magnetizable nanoparticle by a gold-thiol linkage.

**10**. The method of claim 1, wherein the nanoparticle is nonmagnetic in the absence of a magnetic field and is magnetic in the presence of a magnetic field.

**11**. The method of claim 1, wherein the nanoparticle is a paramagnetic particle, a superparamagnetic particle, or a synthetic ferrimagnetic particle.

**12**. The method of claim 1, wherein the nanoparticle comprises a noble metal surface layer.

**13**. The method of claim 1, wherein the nanoparticle comprises a gold surface layer.

**14**. The method of claim 1, wherein the nanoparticle has a mean diameter of about 5 nm to about 250 nm.

**15**. The method of claim 1, wherein the nanoparticle has a mean diameter of about 5 nm to about 20 nm.

**16**. The method of claim 1, wherein the substrate comprises a high sensitivity spin valve or a magnetic tunnel junction detector array.

**17**. The method of claim 1, wherein the detecting step comprises applying an external magnetic field gradient.

**18**. The method of claim 1, wherein the detecting step comprises applying a DC bias field and an AC tickling field.

**19**. The method of claim 1, wherein the detecting step comprises applying an external magnetic field gradient and detecting a net magnetic moment.

**20**. A spin valve detector array useful for the detection of magnetic nanoparticles, the detector array comprising a plurality of detection sites; wherein:

each of the plurality of detection sites comprise:

a first ferromagnetic layer;

a non-magnetic layer facially contacting the first ferromagnetic layer;

a second ferromagnetic layer facially contacting the non-magnetic layer;

a passivation layer facially contacting the second ferromagnetic layer; and

a binding molecule covalently bonded to the passivation layer; and

the binding molecule is selected from the group consisting of a nucleic acid, natural or synthetic DNA, natural or synthetic RNA, a peptide, a protein, an antibody, a lipid, a virus, a polymer, a toxin compound, a pharmaceutical compound, a biohazard compound, and an explosive compound.

**21**. The array of claim 20, wherein the first ferromagnetic layer comprises Co, Co alloys, Iron, Iron alloys, Fe—N, $Fe_3O_4$, Fe—Zr—Nb—B, Ni, Ni alloys, or mixtures thereof. This ferromagnetic layer is pinned by an exchange-bias layer or a synthetic ferromagnetic layer.

**22**. The array of claim 20, wherein the second ferromagnetic layer comprises Co, Co alloys, Iron, Iron alloys, Fe—N, $Fe_3O_4$, Fe—Zr—Nb—B, Ni, Ni alloys, or mixtures thereof.

**23**. The array of claim 20, wherein the passivation layer is about 1 nm to about 10 nm in thickness.

**24**. The array of claim 20, wherein the passivation layer comprises gold, tantalum, or glass. On the top of the passivation layer there may be an aperture to confine the DNA binding area.

**25**. The array of claim 20, wherein the non-magnetic layer comprises ruthenium, a ruthenium alloy, chromium, a chromium alloy, gold, a gold alloy, a noble metal, a noble metal alloy, or mixtures thereof.

**26**. The array of claim 20, further comprising a row decoder, a column decoder, a preamplifier, and at least one current source.

**27**. The array of claim 20, further comprising microfluidic circuits.

**28**. The array of claim 20, comprising a plurality of detection sites.

**29**. A magnetic tunnel junction (MTJ) detector array useful for the detection of magnetic nanoparticles, the detector array comprising a plurality of detection sites; wherein:

each of the plurality of detection sites comprise:

a bottom electrode;

a plurality of magnetic layers contacting the bottom electrode;

a tunnel barrier contacting at least one of the plurality of magnetic layers;

a ferromagnetic layer (the second magnetic layer) on the top of the tunnel barrier;

a gold layer contacting the second magnetic layer;

a conductive layer, typically with an aperture exposing part of the gold covered MTJ, contacting the gold layer; and