CLAIMS

What is claimed is:

1. A filtration apparatus for preferentially transmitting objects of interest, wherein the filtration apparatus comprises:

a channel system comprising at least one channel;

a channel disposed within the channel system, extending from at least one first opening at a first reservoir to at least one second opening at a second reservoir, and facilitating the diffusion of objects of interest through the channel from the first reservoir to the second reservoir;

a region of reduced cross-sectional area disposed within the channel, wherein the cross-sectional area is viewed along the length of the channel; and wherein the minimum characteristic width of the reduced cross-sectional area is measured perpendicular to the length of the channel and is less than 1000 times the mean free path of objects of interest at that location;

a first gradient segment disposed within the channel, wherein the first gradient segment extends from the region of reduced cross-sectional area towards a region of increased cross-sectional area in the direction of the first reservoir; and

a second gradient segment disposed within the channel, wherein the second gradient segment extends from the region of reduced cross-sectional area towards a region of increased cross-sectional area in the direction of the second reservoir, and wherein the increase in the cross-sectional area of the channel per unit length of the channel in the second gradient segment is less than the increase in the cross-sectional area of the channel per unit length of the channel in the first gradient segment

2. The filtration apparatus of claim 1, wherein at least a portion of the interactions between the objects of interest and the boundaries of the channel system comprise diffuse reflections, or scattering events

3. The filtration apparatus of claim 2, wherein the majority of interactions between the objects of interest and the boundaries of the channel system or comprise diffuse reflections, or scattering events

4. The filtration apparatus of claim 1, wherein the majority of interactions between the objects of interest and the boundaries of the channel system comprise specular reflections, or do not comprise scattering events

5. The filtration apparatus of claim 1, wherein the increase in the cross-sectional area of the channel per unit length of the channel in the first gradient segment is infinite

6. The filtration apparatus of claim 1, wherein the first or second gradient segment can comprise segments of constant cross-sectional area along the length of the channel, wherein the characteristic width of at least one segment of constant cross-sectional area along the length of a channel is less than 1000 times the mean free path of an object of interest within the channel

7. The filtration apparatus of claim 1, wherein a channel is disposed within a bulk material, and exclusively diffusively connects one first opening to one second opening

8. The filtration apparatus of claim 1, wherein at least a portion of a channel is disposed within an interior region comprising filtered objects, wherein the channel describes the shortest path of an object of interest between the first and second reservoirs through the filtering apparatus for a given location within the filtering apparatus, and wherein the channel comprises regions within the interior region which are accessible to the objects of interest, and wherein the concentration of filtered objects within the interior region is greater than the concentration of filtered objects outside of the interior region

9. The filtration apparatus of claim 8, wherein a filtering surface is located between the interior region and the first reservoir

10. The filtration apparatus of claim 9, wherein the characteristic width of a channel in the filtering surface is smaller than the average characteristic width of a channel in the interior region, the transition from the filtering surface to the interior region thereby forming a second gradient segment

11. The filtration apparatus of claim 9, wherein the cross-sectional area of a channel in the filtering surface along the length of the channel increases in the direction of the second reservoir, thereby forming a second gradient segment within the filtering surface

12. The filtration apparatus of claim 8, wherein a filtering surface is located between the interior region and the second reservoir

13. The filtration apparatus of claim 12, wherein the characteristic width of a channel in the filtering surface is larger than the average characteristic width of a channel in the interior region, the transition from the interior region to the filtering surface thereby forming a second gradient segment

14. The filtration apparatus of claim 12, wherein the cross-sectional area of a channel in the filtering surface along the length of the channel increases in the direction of the second reservoir, thereby forming a second gradient segment within the filtering surface

15. The filtration apparatus of claim 8, wherein the average width of a channel in the interior region increases throughout at least a portion of the interior region in the direction of the second reservoir, thereby forming a second gradient segment within the interior region

16. The filtration apparatus of claim 8, wherein the filtered objects are at least partially contained by a force field, wherein a body force per unit mass acts on at least a portion of the filtered objects, and wherein the force field is provided by a body force per unit mass generating apparatus

17. The filtration apparatus of claim 16, wherein the body force per unit mass is electromagnetic in nature

18. The filtration apparatus of claim 16, wherein the body force per unit mass is gravitational or inertial in nature

19. The filtration apparatus of claim 8, wherein at least a portion of the filtered objects are subject to attractive forces between neighboring filtered objects, the filtered objects thereby contributing to the bulk of a porous bulk material, and wherein the channel comprises regions within the porous bulk material which are accessible to the objects of interest

20. The filtration apparatus of claim 1, wherein a portion of the length of a channel is perpendicular to another portion of the length of the same channel

21. The filtration apparatus of claim 1, wherein the objects of interest comprise an atom, a molecule, a dust particle, an aerosol, a proton, an electron, or a positively or negatively charged ion, photons, phonons, or acoustic waves, or combinations of any of the foregoing

22. The filtration apparatus of claim 1, wherein the objects of interest comprise virtual particles, virtual photons, virtual electrons, or virtual positrons, or variations thereof, or combinations of any of the foregoing

23. The filtering apparatus of claim 1, wherein a channel system comprises a planar array of channels

24. A system comprising two or more of the filtering apparatuses of claim 1

25. The system of claim 24, wherein at least one of filtering apparatuses is coupled in series with another filtering apparatus

26. A method of preferentially transmitting objects of interest from a first reservoir to a second reservoir, comprising:

providing a filtering apparatus of claim 1, wherein a first opening of a channel is diffusively coupled to the first reservoir, and a second opening of a channel is diffusively coupled to the second reservoir; and

to thereby preferentially transmit objects of interest from the first reservoir to the second reservoir