Simulation Based on Michel Fodje's epr-simple simulation translated from Python to Mathematica by John Reed 13 Nov 2013
Modified by Fred Diether for Completely Local-Realistic Sep 2021
Some parts by Bill Nelson.

Set Run Time Parameters, Initialize Arrays and Tables

```
In[4978]:= m = 10000;
trialDeg = 721;
s1 = ConstantArray[0, m];
s2 = ConstantArray[0, m];
λ1 = ConstantArray[0, m];
A12 = Table[{0, 0, 0, 0}, m];
A22 = Table[{0, 0, 0, 0}, m];
B12 = Table[{0, 0, 0, 0}, m];
B22 = Table[{0, 0, 0, 0}, m];
a1 = ConstantArray[0, m];
b1 = ConstantArray[0, m];
A = ConstantArray[0, m];
B = ConstantArray[0, m];
nPP = ConstantArray[0, trialDeg];
nNN = ConstantArray[0, trialDeg];
nPN = ConstantArray[0, trialDeg];
nNP = ConstantArray[0, trialDeg];
nAP = ConstantArray[0, trialDeg];
nBP = ConstantArray[0, trialDeg];
nAN = ConstantArray[0, trialDeg];
nBN = ConstantArray[0, trialDeg];
ϕ = 3.1; β = 0.32; ξ = -16;  (*Adustable parameters for fine tuning*)
```

Generating Particle Data with Three Independent Do-Loops

```
In[5000]:= Do[θ = RandomReal[{0, 360}];  (*Singlet vector angle*)  (*Hidden Variable*)
 λ1[[i]] = β (Cos[θ/ϕ]^2);
 s1[[i]] = θ;
 s2[[i]] = θ + 180, {i, m}]     (*Conservation of angular momentum*)

In[5001]:= Do[a = RandomInteger[{0, 360}];  (*Detector vector angle 1 degree increments*)
 If[Abs[Cos[(a - s1[[i]]) Degree]] > λ1[[i]], Aa1 = -Sign[Cos[(a - s1[[i]]) Degree]], Aa1 = 0];
 If[Abs[Cos[(a - s1[[i]]) Degree]] < λ1[[i]],
  Aa2 = -Sign[Sin[(a - s1[[i]] + ξ) Degree]], Aa2 = 0];
 A0 = -Sign[Sin[(a - s1[[i]] + ξ) Degree]];
 A12[[i]] = {a, Aa1, i, A0};
 A22[[i]] = {a, Aa2, i, A0}, {i, m}]
outA1 = DeleteCases[A12, {_, 0, _, _}];  (*Split into outA1 and outA2*)
outA2 = DeleteCases[A22, {_, 0, _, _}];
```

In[5003]:=
```
Do[b = RandomInteger[{0, 360}];  (*Detector vector angle 1 degree increments*)
 If[Abs[Cos[(b - s2[[i]]) Degree]] > λ1[[i]], Bb1 = -Sign[Cos[(b - s2[[i]]) Degree]], Bb1 = 0];
 If[Abs[Cos[(b - s2[[i]]) Degree]] < λ1[[i]],
  Bb2 = -Sign[Sin[(b - s2[[i]] + ξ) Degree]], Bb2 = 0];
 B0 = -Sign[Sin[(b - s2[[i]] + ξ) Degree]];
 B12[[i]] = {b, Bb1, i, B0};
 B22[[i]] = {b, Bb2, i, B0}, {i, m}]
outB1 = DeleteCases[B12, {_, 0, _, _}];    (*Split into outB1 and outB2*)
outB2 = DeleteCases[B22, {_, 0, _, _}];
```

Matching Events Observed by Alice and Bob using Trial Numbers

In[5005]:=
```
kB1 = outA1[[All, 3]]; (*Two lists of only trial numbers used for matching*)
kA1 = outB1[[All, 3]];
```

Local Detection Analysis of the Events Observed by Alice

In[5007]:=
```
listA3 = Select[outA1, Intersection[{#[[3]]}, kA1] != {#[[3]]} &];
M1 = Length[listA3];
tna = listA3[[All, 3]];
outA4 = Select[outA1, Intersection[{#[[3]]}, tna] != {#[[3]]} &];
outA5 = Table[{0, 0, 0, 0}, M1];
ssca = ConstantArray[0, M1];
```

For the spinorial sign changes we will need eq. (12).

$$\mathbf{q}(\eta_{\mathbf{sn}} + \delta\,\pi,\, \mathbf{r}) = (-1)^{\delta}\, \mathbf{q}(\eta_{\mathbf{sn}},\, \mathbf{r}) \quad \text{for } \delta = 0, 1, 2, 3, \ldots$$

In[5013]:=
```
Do[If[listA3[[i]][[2]] == listA3[[i]][[4]], δ = 0, δ = 1];
 If[δ == 0, ssca[[i]] = 1, ssca[[i]] = -1];  (*spinorial sign change*)
outA5[[i]] = {listA3[[i]][[1]],
   ssca[[i]] * listA3[[i]][[2]], listA3[[i]][[3]], listA3[[i]][[4]]}, {i, M1}]
outA = Sort[Catenate[{outA2, outA4, outA5}], #1[[3]] < #2[[3]] &];
(*Combine lists and sort*)
a1 = outA[[All, 1]];  (*These results are what Alice observes as defined in Eq.(??)*)
A =  outA[[All, 2]];
```

Local Detection Analysis of the Events Observed by Bob

In[5015]:=
```
listB3 = Select[outB1, Intersection[{#[[3]]}, kB1] != {#[[3]]} &];
M2 = Length[listB3];
tnb = listB3[[All, 3]];
outB4 = Select[outB1, Intersection[{#[[3]]}, tnb] != {#[[3]]} &];
outB5 = Table[{0, 0, 0, 0}, M2];
sscb = ConstantArray[0, M2];
```

In[5021]:=
```
Do[If[listB3[[i]][[2]] == listB3[[i]][[4]], δ = 0, δ = 1];
 If[δ == 0, sscb[[i]] = 1, sscb[[i]] = -1];
 (*spinorial sign change*)outB5[[i]] = {listB3[[i]][[1]],
   sscb[[i]] * listB3[[i]][[2]], listB3[[i]][[3]], listB3[[i]][[4]]}, {i, M2}]
outB = Sort[Catenate[{outB2, outB4, outB5}], #1[[3]] < #2[[3]] &];
(*Combine lists and sort*)
b1 = outB[[All, 1]];  (*These results are what Bob observes as defined in Eq.(??)*)
B =  outB[[All, 2]];
```

In[5023]:=
```
m4 = Length[outA5];
listA6 = Table[{0, 0, 0, 0}, m4];
Do[If[ssca[[i]] == -1, listA6[[i]] = outA5[[i]], listA6[[i]] = 0], {i, m4}]
listA7 = DeleteCases[listA6, 0];
listA83 = listA7[[All, 3]];
listB9 = Select[outB, Intersection[{#[[3]]}, listA83] == {#[[3]]} &];
m5 = Length[listB9];
listB9 = Table[{0, 0, 0, 0}, m5];
bb1 = ConstantArray[0, m5];
Do[If[Abs[Cos[(listB9[[i]][[1]] - s2[[i]]) Degree]] < λ1[[i]],
  bb1[[i]] = 1, bb1[[i]] = 0], {i, m5}]
N[Total[bb1] / m] *
 100
```

Out[5033]= 0.61

So that is the percentage of possible sign changes in A due to a change of angle b. This is “possible” events. We don’t know for sure if they actually are due to a change of angle b. Now, we need to average 10 of these.

In[5035]:=
```
(0.35 + 0.61 + 0.52 + 0.53 + 0.58 + 0.5 + 0.59 + 0.51 + 0.59 + 0.61) / 10
```

Out[5035]= 0.539

```
100 - 0.539
```

Out[5036]= 99.461

So, we are for sure about 99.461 percent local for those that don’t accept the spinorial sign changes as the reason. The changes in B are probably about the same.