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 Aug 2021
Some matching parts by Bill Nelson

Set Run Time Parameters, Initialize Arrays and Tables

In[ ]:=
```
m = 400000;
trialDeg = 721;
s = ConstantArray[0, m];
λ = ConstantArray[0, m];
outA = Table[{0, 0, 0, 0, 0}, m];
outB = Table[{0, 0, 0, 0, 0}, m];
outA4 = Table[{0, 0, 0, 0, 0}, m];
outB4 = Table[{0, 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];
η = 3;
β = 0.3;
ξ = -15;
```

Generate Particle Data with 3 Do Loops

In[ ]:=
```
Do[e = RandomReal[{0, 360}]; (*Singlet vector angle*)
 s[[i]] = e;
 λ[[i]] = β (Cos[e/η]^2), (*Hidden Variables*)
 {i, m}]
```

In[ ]:=
```
Do[a = RandomInteger[{0, 360}]; (*Detector vector angle 1 degree increments*)
 If[Abs[Cos[((a - s[[i]]) Degree)]] < λ[[i]], C1 = f1, C1 = g1];
 If[Abs[Cos[((a - s[[i]]) Degree)]] > λ[[i]],
  Aa = -Sign[Cos[((a - s[[i]]) Degree)]], Aa = -Sign[Sin[((a - s[[i]] + ξ) Degree)]]];
 A5 = -Sign[Sin[((a - s[[i]] + ξ) Degree)]];
 outA4[[i]] = {a, Aa, i, C1, A5}, {i, m}]
outA1 = Select[outA4, MemberQ[#, g1] &];
outA2 = Select[outA4, MemberQ[#, f1] &];
```

```
In[∘]:= Do[b = RandomInteger[{0, 360}];  (*Detector vector angle 1 degree increments*)
   If[Abs[Cos[((b - s[[i]]) Degree)]] < λ[[i]], C2 = f2, C2 = g2];
   If[Abs[Cos[((b - s[[i]]) Degree)]] > λ[[i]],
    Bb = Sign[Cos[((b - s[[i]]) Degree)]], Bb = Sign[Sin[((b - s[[i]] + ξ) Degree)]]];
   B5 = Sign[Sin[((b - s[[i]] + ξ) Degree)]];
   outB4[[i]] = {b, Bb, i, C2, B5}, {i, m}]
  outB1 = Select[outB4, MemberQ[#, g2] &];
  outB2 = Select[outB4, MemberQ[#, f2] &];
```

Match Events Using Trial Numbers

```
In[∘]:= listad = outA1[[All, 3]];
  listbd = outB1[[All, 3]];
```

Local Detection Analysis of Events Observed by Alice

```
In[∘]:= listA4 = Select[outA1, Intersection[{#[[3]]}, listbd] == {#[[3]]} &];
  listad2 = outA1[[All, 3]];
  listad3 = listA4[[All, 3]];
  listA3 = Select[outA1, Intersection[{#[[3]]}, listad3] != {#[[3]]} &];
  listAa4 = Select[listA4, Intersection[{#[[3]]}, listad2] != {#[[3]]} &];
  M = Length[listA3];
  listA6 = Table[{0, 0, 0, 0, 0}, M];
  a2 = ConstantArray[0, M];
  A2 = ConstantArray[0, M];
  ind2 = ConstantArray[0, M];
  A3 = ConstantArray[0, M];
  A7 = ConstantArray[0, M];
  A4 = ConstantArray[0, M];
  A6 = ConstantArray[0, M];
  a2 = listA3[[All, 1]];
  A2 = listA3[[All, 2]];
  ind2 = listA3[[All, 3]];
  A7 = listA3[[All, 5]];
  Do[A4 = A2[[i]]; A6 = A7[[i]];
   If[A4 == A6, A2 = A2, A2 = A7];
   listA6[[i]] = {a2[[i]], A2[[i]], ind2[[i]], f1, A7[[i]]}, {i, M}]
  outA = Sort[Catenate[{listA4, outA2, listA6}], #1[[3]] < #2[[3]] &];
  a1 = outA[[All, 1]];
  A = outA[[All, 2]];
```

Local Detection Analysis of Events Observed by Bob

```
In[•]:= listB4 = Select[outB1, Intersection[{#[[3]]}, listad] == {#[[3]]} &];
listbd2 = outB1[[All, 3]];
listbd3 = listB4[[All, 3]];
listB3 = Select[outB1, Intersection[{#[[3]]}, listbd3] != {#[[3]]} &];
listBb4 = Select[listB4, Intersection[{#[[3]]}, listbd2] != {#[[3]]} &];
M2 = Length[listB3];
listB6 = Table[{0, 0, 0, 0, 0}, M2];
b2 = ConstantArray[0, M2];
B2 = ConstantArray[0, M2];
ind3 = ConstantArray[0, M2];
B3 = ConstantArray[0, M2];
B7 = ConstantArray[0, M2];
B4 = ConstantArray[0, M2];
B6 = ConstantArray[0, M2];
b2 = listB3[[All, 1]];
B2 = listB3[[All, 2]];
ind3 = listB3[[All, 3]];
B7 = listB3[[All, 5]];
Do[B4 = B2[[i]]; B6 = B7[[i]];
 If[B4 == B6, B2 = B2, B2 = B7];
 listB6[[i]] = {b2[[i]], B2[[i]], ind3[[i]], f1, B7[[i]]}, {i, M2}]
outB = Sort[Catenate[{listB4, outB2, listB6}], #1[[3]] < #2[[3]] &];
b1 = outB[[All, 1]];
B = outB[[All, 2]];
```

Statistical Analysis of Particle Data

```
In[•]:= Do[θ = a1[[j]] - b1[[j]] + 361;  (*All angles are shifted by 2π since θ is an index*)
 aliceD = A[[j]]; bobD = B[[j]];
 If[aliceD == 1, nAP[[θ]]++];
 If[bobD == 1, nBP[[θ]]++];
 If[aliceD == -1, nAN[[θ]]++];
 If[bobD == -1, nBN[[θ]]++];
 If[aliceD == 1 && bobD == 1, nPP[[θ]]++];
 If[aliceD == 1 && bobD == -1, nPN[[θ]]++];
 If[aliceD == -1 && bobD == 1, nNP[[θ]]++];
 If[aliceD == -1 && bobD == -1, nNN[[θ]]++], {j, m}]
```

Calculate Mean Values and Plot

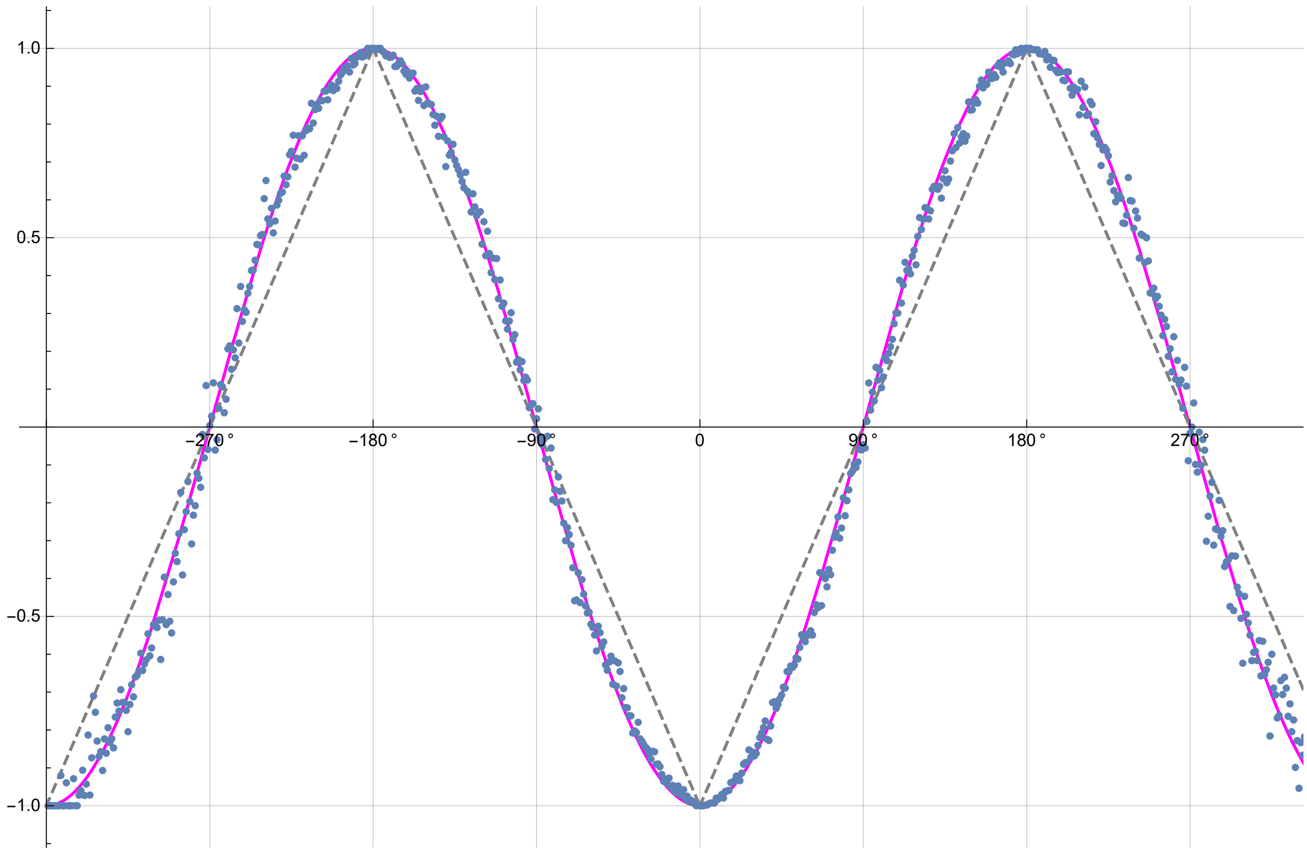
```
In[•]:= pPP = 0; pPN = 0; pNP = 0; pNN = 0;
mean = ConstantArray[0, trialDeg];
Do[sum = nPP[[i]] + nPN[[i]] + nNP[[i]] + nNN[[i]];
If[sum == 0, Goto[jump],
   {pPP = nPP[[i]] / sum;
    pNP = nNP[[i]] / sum;
    pPN = nPN[[i]] / sum;
    pNN = nNN[[i]] / sum;
mean[[i]] = pPP + pNN - pPN - pNP}];
 Label[jump], {i, trialDeg}]
```

In[∘]:=
```
simulation = ListPlot[mean, PlotMarkers → {Automatic, Tiny}];
negcos = Plot[-Cos[x Degree], {x, 0, 720}, PlotStyle → {Magenta},
   Ticks → {{{0, -360 °}, {90, -270 °}, {180, -180 °}, {270, -90 °}, {360, 0 °}, {450, 90 °},
      {540, 180 °}, {630, 270 °}, {720, 360 °}}, Automatic}, GridLines → Automatic];
p1 = Plot[-1 + (2 x Degree) / π, {x, 0, 180}, PlotStyle → {Gray, Dashed}];
p2 = Plot[3 - 2 x Degree / π, {x, 180, 360}, PlotStyle → {Gray, Dashed}];
p3 = Plot[-5 + 2 x Degree / π, {x, 360, 540}, PlotStyle → {Gray, Dashed}];
p4 = Plot[7 - 2 x Degree / π, {x, 540, 720}, PlotStyle → {Gray, Dashed}];
```

Compare mean values with -Cosine Curve and compute averages

In[∘]:=
```
Show[negcos, p1, p2, p3, p4, simulation]
```

Out[∘]=



```
In[◦]:= AveA = N[Sum[A[[i]], {i, m}] / m];
AveB = N[Sum[B[[i]], {i, m}] / m];
Print["AveA = ", AveA]
Print["AveB = ", AveB]
PAP = N[Sum[nAP[[i]], {i, trialDeg}]];
PBP = N[Sum[nBP[[i]], {i, trialDeg}]];
PAN = N[Sum[nAN[[i]], {i, trialDeg}]];
PBN = N[Sum[nBN[[i]], {i, trialDeg}]];
PA1 = PAP / (PAP + PAN);
PB1 = PBP / (PBP + PBN);
Print["P(A+)= ", PA1]
Print["P(B+)= ", PB1]
totAB = Sum[nPP[[i]] + nNN[[i]] + nPN[[i]] + nNP[[i]], {i, trialDeg}]
PP = N[Sum[nPP[[i]], {i, trialDeg}] / totAB]
NN = N[Sum[nNN[[i]], {i, trialDeg}] / totAB]
PN = N[Sum[nPN[[i]], {i, trialDeg}] / totAB]
NP = N[Sum[nNP[[i]], {i, trialDeg}] / totAB]
CHSH = Abs[N[mean[[315]]] - N[mean[[225]]] + N[mean[[405]]] + N[mean[[45]]]]

AveA = -0.001525

AveB = 0.00118

P(A+)= 0.499238

P(B+)= 0.50059

Out[◦]= 400 000

Out[◦]= 0.2495

Out[◦]= 0.249673

Out[◦]= 0.249738

Out[◦]= 0.25109

Out[◦]= 2.8401
```