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 July 2021
Some parts by Bill Nelson

Set Run Time Parameters, Initialize Arrays and Tables

In[1]:=
```
m = 200 000;
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];
outA1 = Table[{0, 0, 0, 0, 0}, m];
outB1 = 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];
```

Generate Particle Data with 3 Do Loops

In[21]:=
```
Do[e = RandomReal[{0, 360}];  (*Singlet vector angle*)
 s[[i]] = e;
 λ[[i]] = 0.3 (Cos[e/2]^2), (*Hidden Variables*)
 {i, m}]
```

In[22]:=
```
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]],
  A1 = -Sign[Cos[((a - s[[i]]) Degree)]], A1 = -Sign[Sin[((a - s[[i]] - 15) Degree)]]];
 AA = -Sign[Sin[((a - s[[i]] - 15) Degree)]];
 outA1[[i]] = {a, A1, i, C1, AA}, {i, m}]
```

In[23]:=
```
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]],
  B1 = Sign[Cos[((b - s[[i]]) Degree)]], B1 = Sign[Sin[((b - s[[i]] - 15) Degree)]]];
 BB = Sign[Sin[((b - s[[i]] - 15) Degree)]];
 outB1[[i]] = {b, B1, i, C2, BB}, {i, m}]
```

Match Events Using Trial Numbers

In[24]:=
```
outA2 = Select[outA1, MemberQ[#, g1] &];
outB2 = Select[outB1, MemberQ[#, g2] &];
listad = outA2[[All, 3]];
listbd = outB2[[All, 3]];
```

In[28]:=
```
listAa1 = Select[outA2, Intersection[{#[[3]]}, listbd] == {#[[3]]} &];
listad2 = outA2[[All, 3]];
listad3 = listAa1[[All, 3]];
listAa3 = Select[outA2, Intersection[{#[[3]]}, listad3] != {#[[3]]} &];
listAa4 = Select[listAa1, Intersection[{#[[3]]}, listad2] != {#[[3]]} &];
M = Length[listAa3];
listAa7 = Table[{0, 0, 0, 0, 0}, M];
a2 = ConstantArray[0, M];
A2 = ConstantArray[0, M];
ind2 = ConstantArray[0, M];
A3 = ConstantArray[0, M];
A5 = ConstantArray[0, M];
A4 = ConstantArray[0, M];
A6 = ConstantArray[0, M];
a2 = listAa3[[All, 1]];
A2 = listAa3[[All, 2]];
ind2 = listAa3[[All, 3]];
A5 = listAa3[[All, 5]];
Do[A4 = A2[[i]]; A6 = A5[[i]];
 If[A4 == A6, A2 = A2, A2 = A5];
 listAa7[[i]] = {a2[[i]], A2[[i]], ind2[[i]], f1, A5[[i]]}, {i, M}]
outA3 = Select[outA1, MemberQ[#, f1] &];
outA = Sort[Catenate[{listAa1, outA3, listAa7}], #1[[3]] < #2[[3]] &];
a1 = outA[[All, 1]];
A = outA[[All, 2]];
```

In[51]:=
```
listBb1 = Select[outB2, Intersection[{#[[3]]}, listad] == {#[[3]]} &];
listbd2 = outB2[[All, 3]];
listbd3 = listBb1[[All, 3]];
listBb3 = Select[outB2, Intersection[{#[[3]]}, listbd3] != {#[[3]]} &];
listBb4 = Select[listBb1, Intersection[{#[[3]]}, listbd2] != {#[[3]]} &];
M2 = Length[listBb3];
listBb7 = Table[{0, 0, 0, 0, 0}, M2];
b2 = ConstantArray[0, M2];
B2 = ConstantArray[0, M2];
ind3 = ConstantArray[0, M2];
B3 = ConstantArray[0, M2];
B5 = ConstantArray[0, M2];
B4 = ConstantArray[0, M2];
B6 = ConstantArray[0, M2];
b2 = listBb3[[All, 1]];
B2 = listBb3[[All, 2]];
ind3 = listBb3[[All, 3]];
B5 = listBb3[[All, 5]];
Do[B4 = B2[[i]]; B6 = B5[[i]];
 If[B4 == B6, B2 = B2, B2 = B5];
 listBb7[[i]] = {b2[[i]], B2[[i]], ind3[[i]], f1, B5[[i]]}, {i, M2}]
outB3 = Select[outB1, MemberQ[#, f2] &];
outB = Sort[Catenate[{listBb1, outB3, listBb7}], #1[[3]] < #2[[3]] &];
b1 = outB[[All, 1]];
B = outB[[All, 2]];
```

Statistical Analysis of Particle Data

In[74]:=
```
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

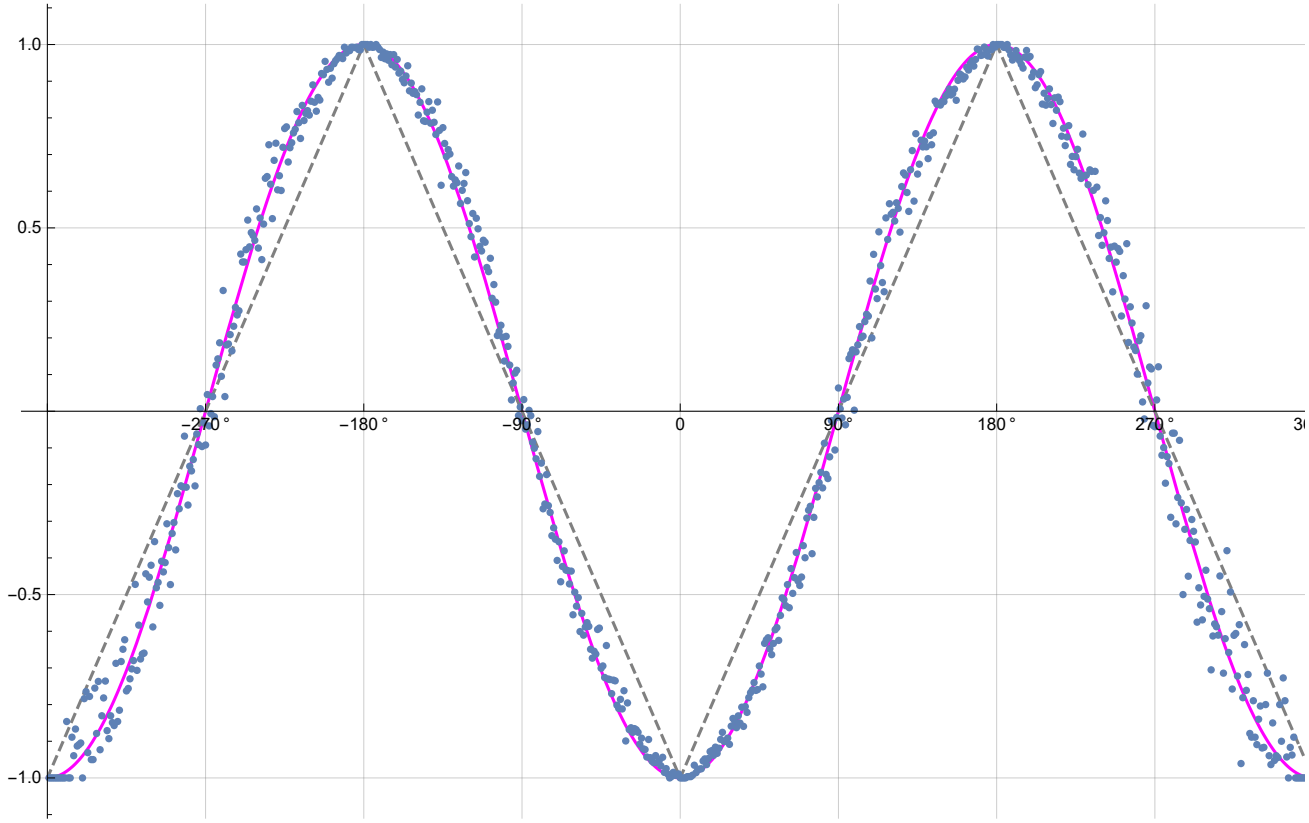
In[75]:=
```
pPP = 0;  pPN = 0;  pNP = 0; pNN = 0;
mean = ConstantArray[0, trialDeg];
Do[sum = nPP[[i]] + nPN[[i]] + nNP[[i]] + nNN[[i]];
If[sum == 0, Goto[jump],
  {pPP = nPP[[i]] / sum;
   pNP = nNP[[i]] / sum;
   pPN = nPN[[i]] / sum;
   pNN = nNN[[i]] / sum;
mean[[i]] = pPP + pNN - pPN - pNP}];
 Label[jump], {i, trialDeg}]
```

In[78]:=
```
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[84]:=
```
Show[negcos, p1, p2, p3, p4, simulation]
```

Out[84]=



In[85]:=
```
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 = 0.00044

AveB = -0.00097

P(A+)= 0.50022

P(B+)= 0.499515
```

Out[97]= 200000

Out[98]= 0.249795

Out[99]= 0.25006

Out[100]= 0.250425

Out[101]= 0.24972

Out[102]= 2.93168