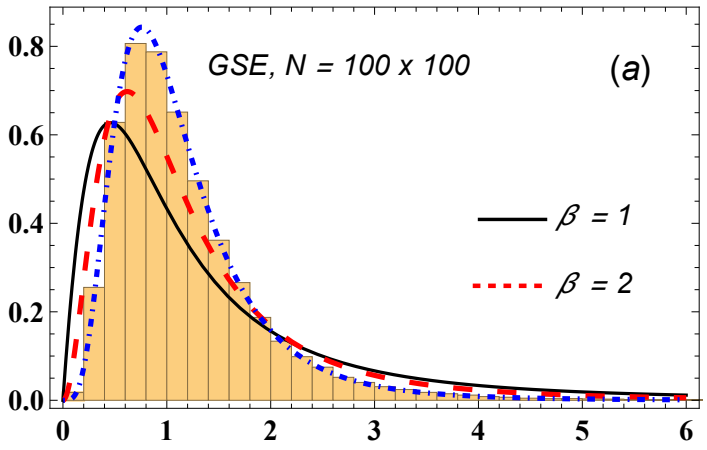
Ratios of Spacings for GSE

```
na = 50; nm = 2000;
eigall = {}; rath = {}; eigvalall = {};
AbsoluteTiming[Monitor[For[ty = 1, ty ≤ nm, ty++,
  {H8 = RandomVariate[GaussianSymplecticMatrixDistribution[na]];
   (*creating the GSE matrix*)
   eigval = Eigenvalues[H8]; (*find the eigenvalues*)
   eigvalall = Join[eigvalall, eigval]; (*All the eigenvalues from the ensemble*)
   seigval = Sort[eigval]; (*sorting to calculate the ratios of spacings*)
   p = Table[seigval[[i]], {i, 1, Length[seigval], 2}];
   (*making a list of alternate eigenvalues due to the degeneracy in GSE*)
   rath = Append[rath, Table[(p[[j + 2]] - p[[j + 1]])/(p[[j + 1]] - p[[j]]), {j, 1, Length[p] - 2}]]
   (*then calculating the ratios of spacings*);}], ty]]
```

Out[18]= {4.42474, Null}

In[26]:=
```
am10n7ps1 = Show[Histogram[Flatten[rath], 90, "PDF", PlotRange → {{0, 6}, All}],
  Plot[{pgoe[r], pgue[r], pSE[r]}, {r, 0, 6}, PlotRange → {{0, 6}, All},
   PlotStyle → {{Black, Thickness[0.005]}, {Red, Dashing[Large], Thickness[0.008]},
     {Blue, DotDashed, Thickness[0.008]}}], Frame → {{True, True}, {True, True}},
  Epilog → {{Inset[Style["GSE, N = 100 x 100", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.65, 0.9}]], {Right, Top}]},
    {Inset[Style["(a)", 18, FontSlant → Italic], Offset[{-1, -1}, Scaled[{0.93, 0.9}]],
      {Right, Top}]}, {Inset[Style["——— β = 1", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.9, 0.65}]], {Right, Top}]},
    {Inset[Style["----- β = 2", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.9, 0.5}]], {Right, Top}]}},
  LabelStyle → {15, Black, Bold, FontFamily → Times}]
```

Out[26]=



All analytical results for ratios of spacings of OE, UE, SP,SE and Wishart

```
pβ1N4[r_] := 32/9 r (1 + r) ((23 + 23 r + 2 r^2)/(2 + r)^7 + (9 * (42 + 91 r + 47 r^2))/(3 + 2 r)^7);
(*Wishart ensemble 4 x 4 *)
pSE[r_] := (729 Sqrt[3] (r + r^2)^4)/(4 π (1 + r + r^2)^7) ;
pgoe[r_] := (27 (r + r^2))/(8 (1 + r + r^2)^(5/2));
pgue[r_] := (81 Sqrt[3] (r + r^2)^2)/(4 π (1 + r + r^2)^4);
psp[r_, ν_] := (Gamma[2 ν + 2] Gamma[ν + 2]^2)/((ν + 1)^2 Gamma[ν + 1]^4) (r^ν/(1 + r)^(2 ν + 2));
```

All analytical results for eigenvector distributions of of OE, UE, SP,SE and Wishart

```
R1[l_, R_] := Gamma[l / 2] (1 - R)^((1 - 3)/2)/(Gamma[(1 - 1)/2] Sqrt[π R]);
R2[l_, R_] := (l - 1) (1 - R)^(1 - 2);
S2[l_, S_] := ((l - 1)/l) e^S (1 - e^S/l)^(1 - 2);
S1[l_, S_] := Gamma[l / 2] Sqrt[e^S]/(Sqrt[π] Gamma[(l - 1) / 2] Sqrt[l]) (1 - e^S/l)^((1 - 3)/2);
na = 50; nm = 2000;
eigall = {}; rath = {}; eigvalall = {}; eigphall = {};
AbsoluteTiming[Monitor[For[ty = 1, ty ≤ nm, ty++,
  {H8 = RandomVariate[CircularSymplecticMatrixDistribution[na]];
   (*creating the CSE matrix, the matrix dimen is 2*na*)
   eigval = Eigenvalues[H8]; (*find the eigenvalues*)
   eigph = ArcTan[Re[eigval], Im[eigval]]; (*find the eigenphases*)
   eigvalall = Join[eigvalall, eigval]; (*All the eigenvalues from the ensemble*)
   eigphall = Join[eigphall, eigph];
   seigval = Sort[eigph]; (*sorting to calculate the ratios of spacings*)
   p = Table[seigval[[i]], {i, 1, Length[seigval], 2}];
   (*making a list of alternate eigenvalues due to the degeneracy in CSE*)
   rath = Append[rath, Table[(p[[j + 2]] - p[[j + 1]])/(p[[j + 1]] - p[[j]]), {j, 1, Length[p] - 2}]]
   (*then calculating the ratios of spacings*);}], ty]]
```

Out[33]= {23.2589, Null}

In[34]:=
```
am10n7ps1 = Show[Histogram[Flatten[rath], 90, "PDF", PlotRange → {{0, 6}, All}],
  Plot[{pgoe[r], pgue[r], pSE[r]}, {r, 0, 6}, PlotRange → {{0, 6}, All},
   PlotStyle → {{Black, Thickness[0.005]}, {Red, Dashing[Large], Thickness[0.008]},
     {Blue, DotDashed, Thickness[0.008]}}], Frame → {{True, True}, {True, True}},
  Epilog → {{Inset[Style["CSE, N = 100 x 100", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.65, 0.9}]], {Right, Top}]},
    {Inset[Style["(a)", 18, FontSlant → Italic], Offset[{-1, -1}, Scaled[{0.93, 0.9}]],
      {Right, Top}]}, {Inset[Style["——— β = 1", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.9, 0.65}]], {Right, Top}]},
    {Inset[Style["- - - - - β = 2", 15, FontSlant → Italic],
      Offset[{-1, -1}, Scaled[{0.9, 0.5}]], {Right, Top}]}},
  LabelStyle → {15, Black, Bold, FontFamily → Times}]
```

Out[34]=