The Rise
and
Fall of the 750
or
Why I never believed in the 750

eilam gross, Santander 2016

Interpreting the Result

Spin 0

2015

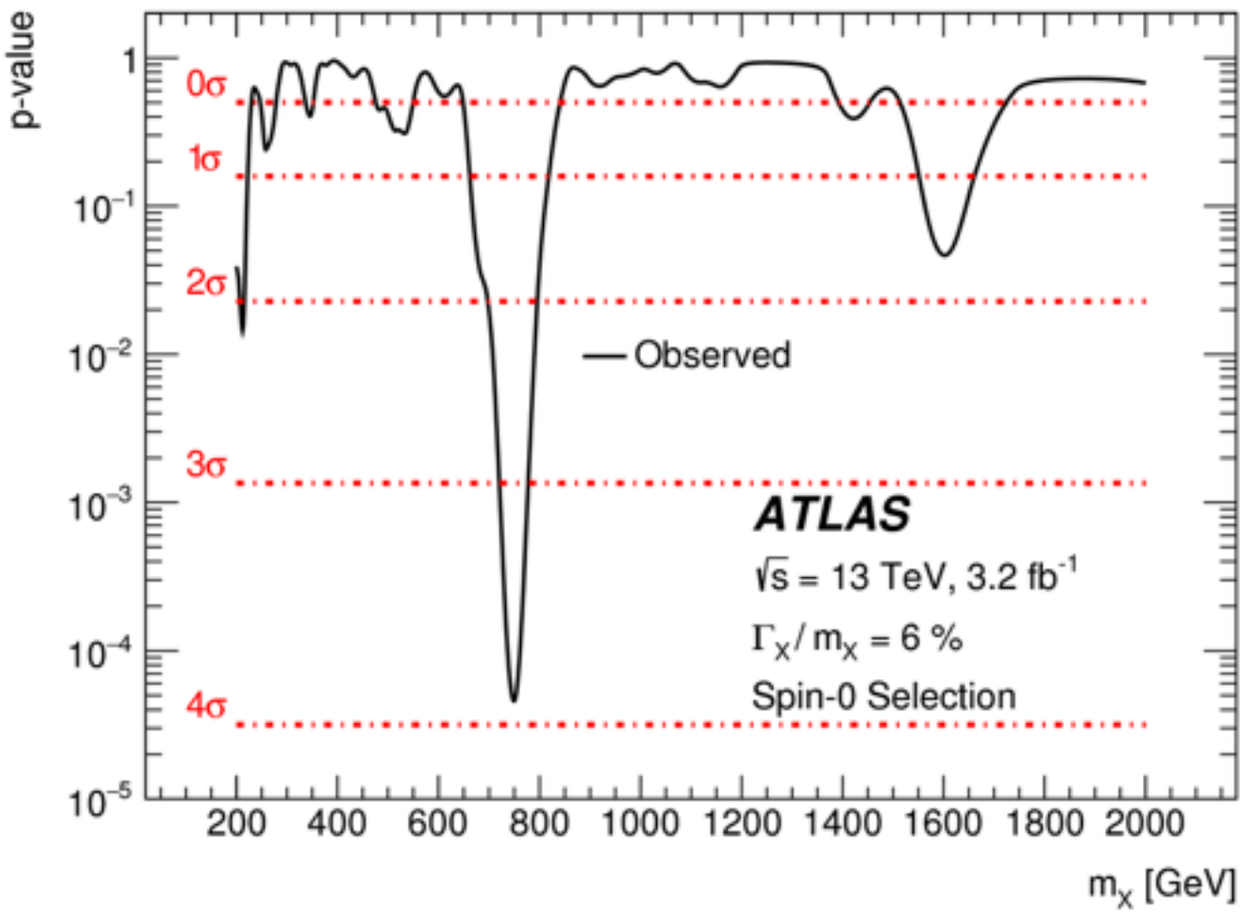
Largest significance

$m_X \sim 750\text{GeV}, \Gamma_X \sim 45\text{GeV}(6\%)$

Local Z = **3.9σ**

Any peak with Z>3.9σ
with m=200-2000 will draw our attention

$$P_{global}(u) \approx p_{local}(u) + E(n_{u_0}) e^{\frac{u_0 - u}{2}}$$



$p_{local} = 5 \cdot 10^{-5}$

$u_0 = 0$

$n_{u_0} = 7 \pm 2.6$

$u = Z^2 = 3.9^2 = 15.2$

$p_{global} = 5 \cdot 10^{-5} + (7 \pm 2.6) e^{-15.2/2} = (2.2 - 4.8) 10^{-3}$

$Z_{global} \sim 2.7 \pm 0.1\sigma$

2.7σ is not something to write home about

Interpreting the Result

Spin 2

2015

2D Scan

Largest significance

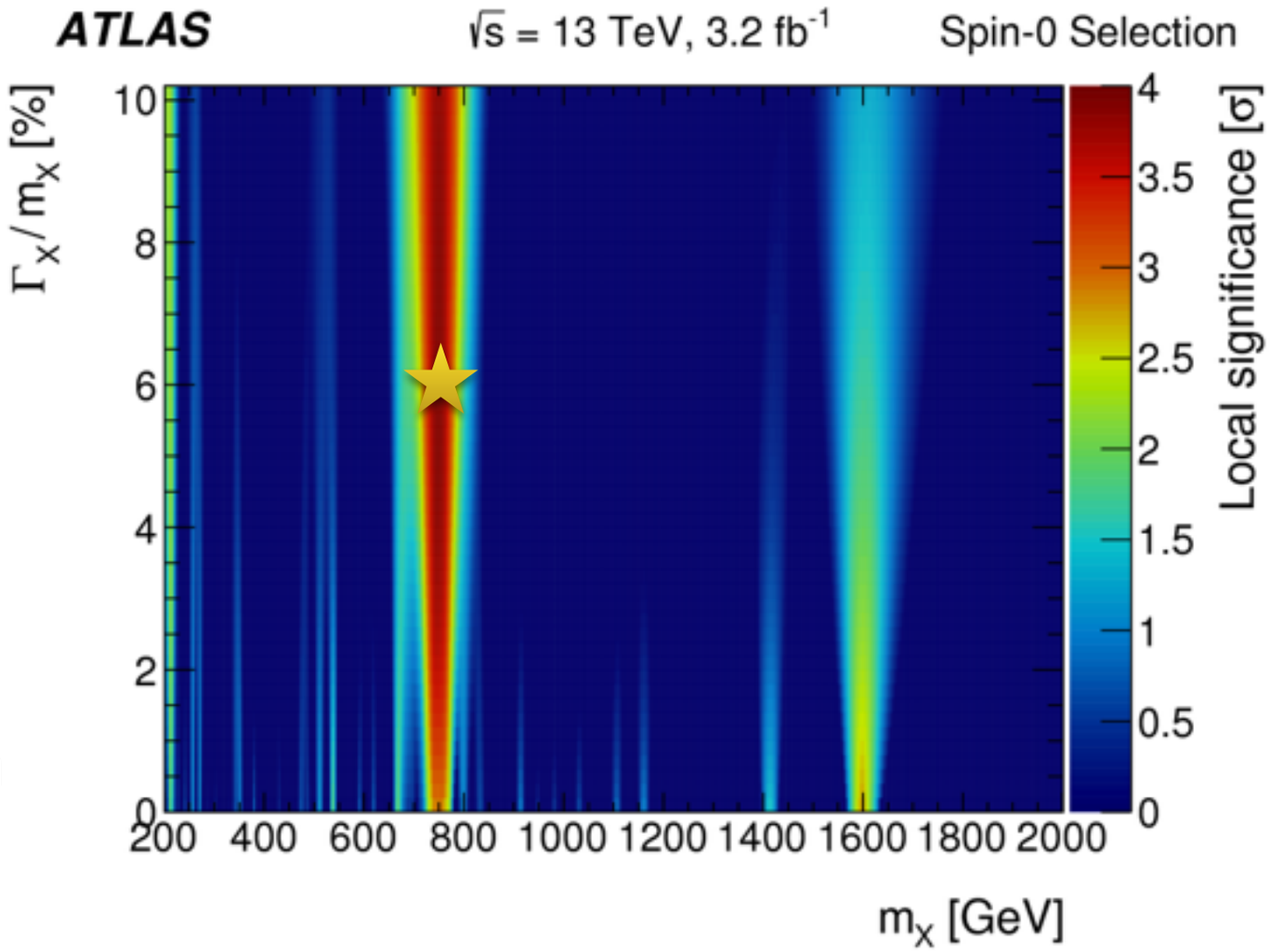
m_X ~ 750GeV, Γ_X ~ 45GeV(6%)

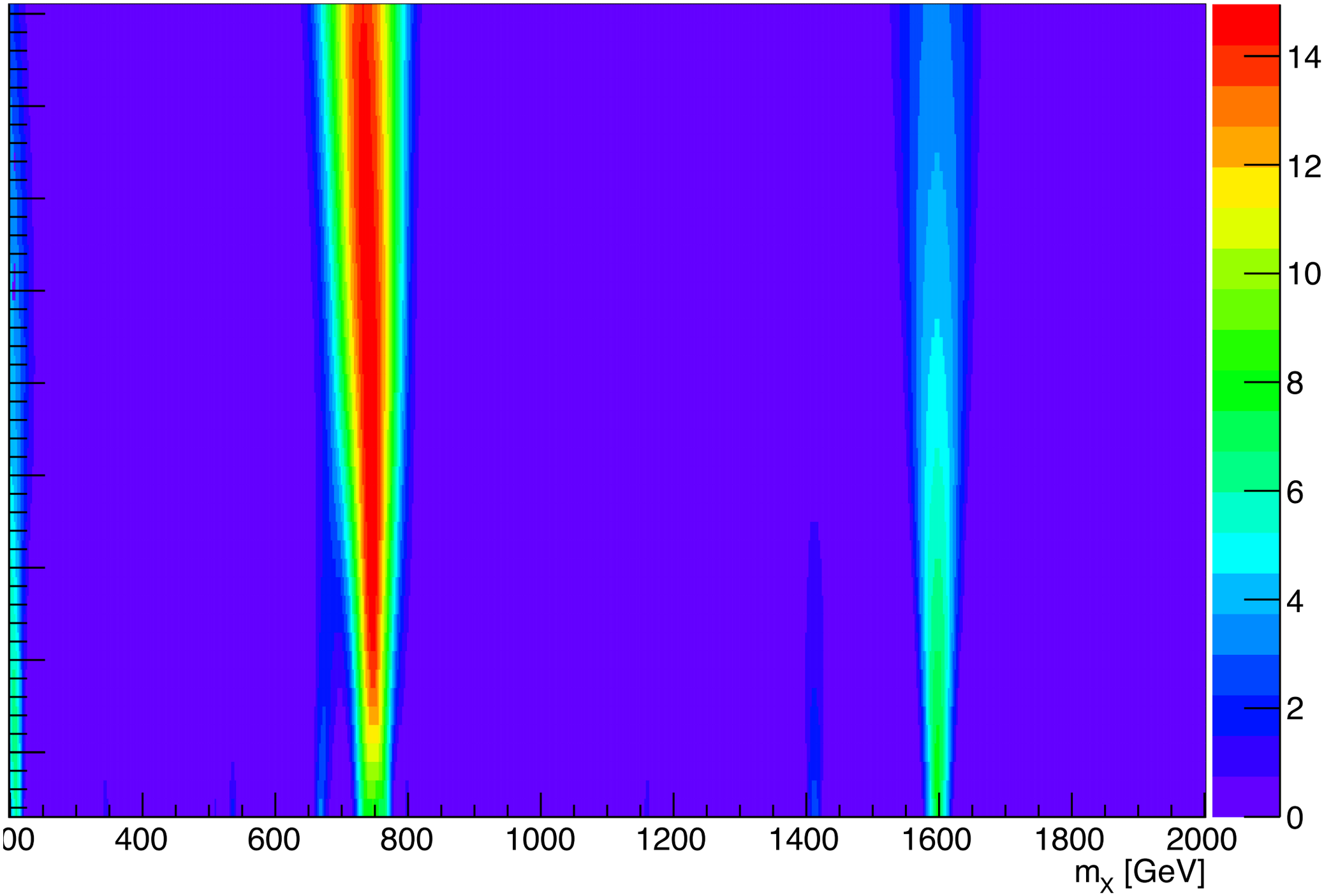
Local Z = 3.9σ

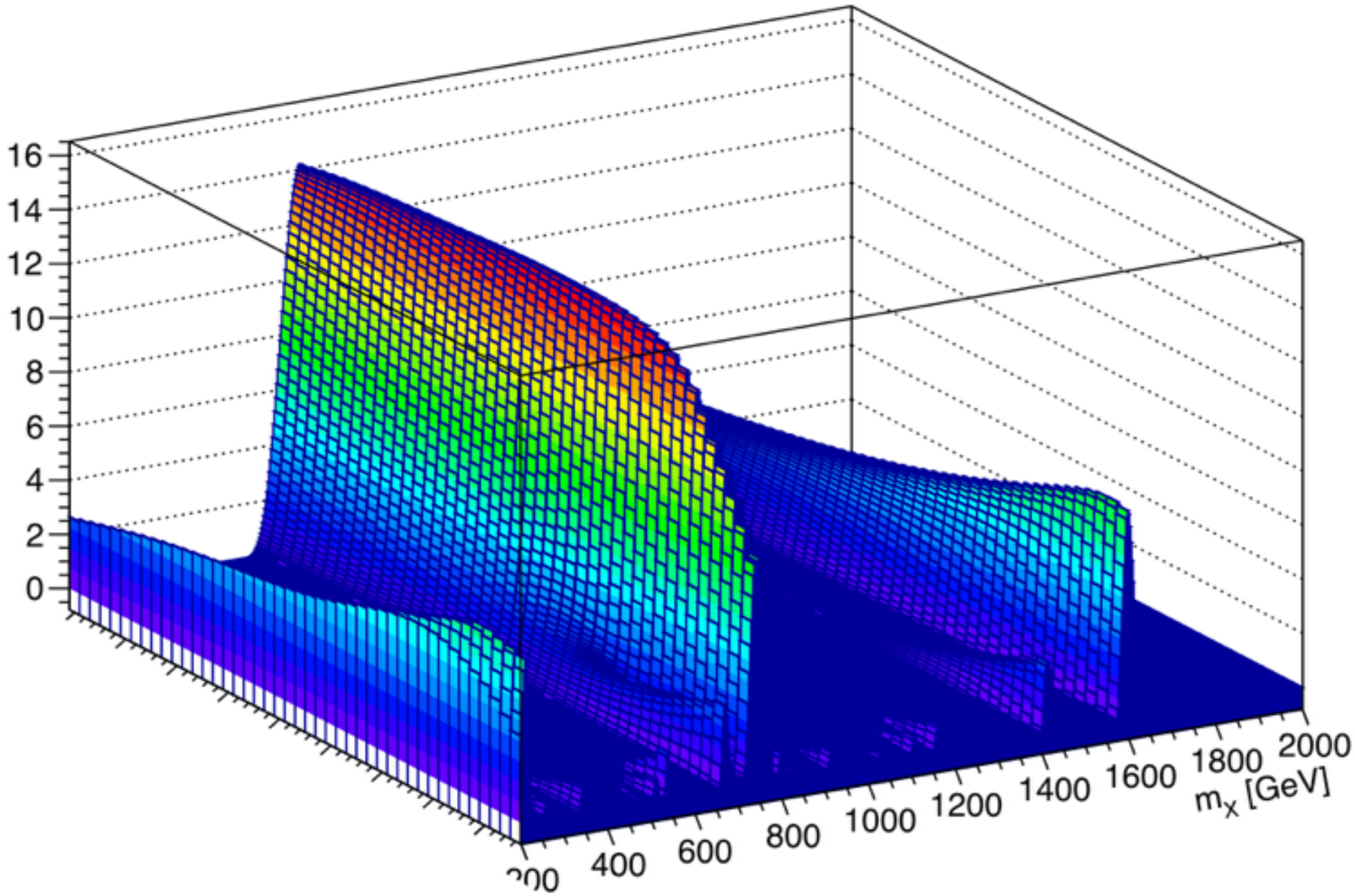
m=200-2000 GeV
Γ_X/m_X=0-10%

Use toys or asymptotic formula from

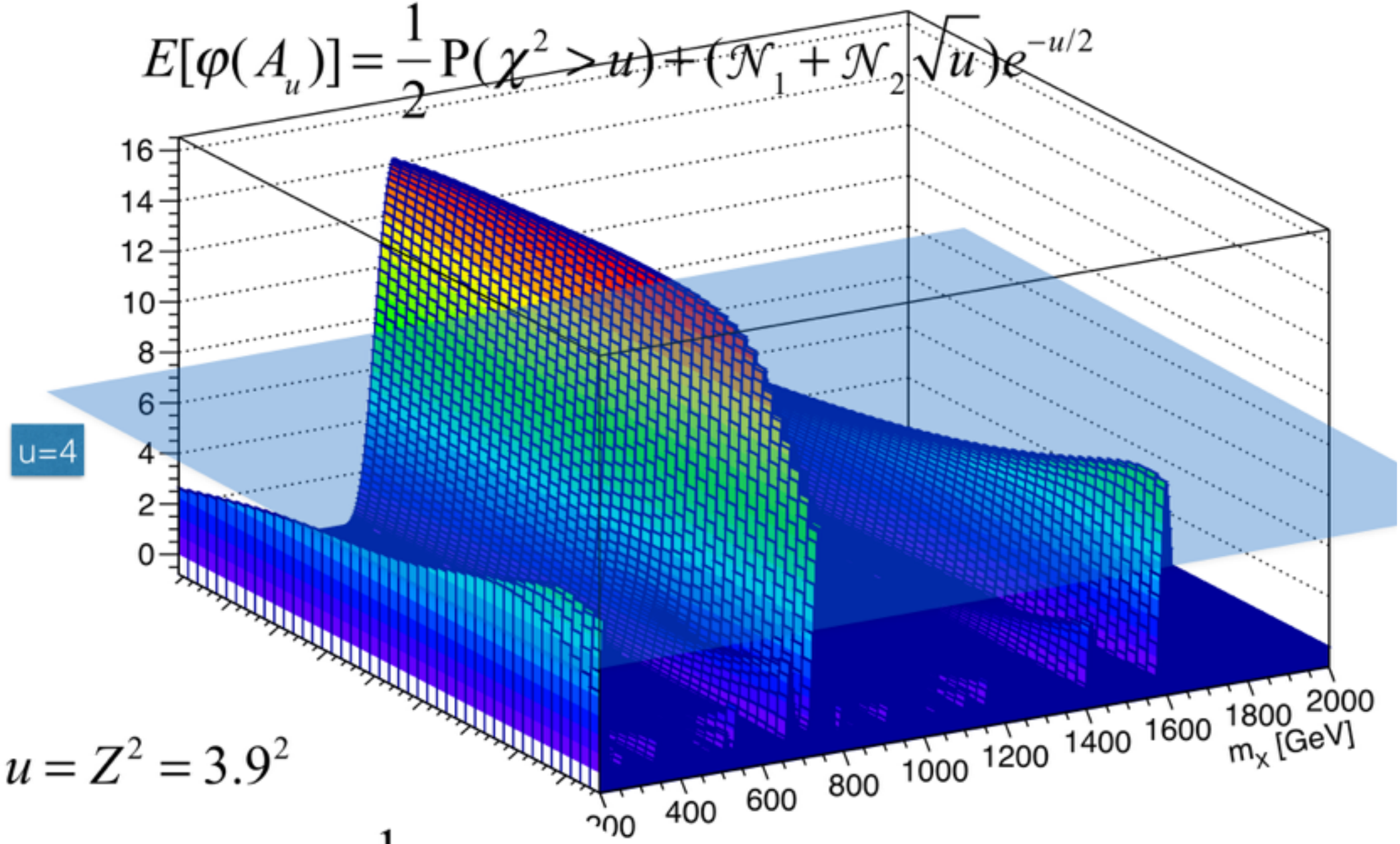
O. Vitells et. al. Astropart. Phys. 35 (2011) 230–234, arXiv:1105.4355




14
12
10
8
6
4
2
0
00
400
600
800
1000
1200
1400
1600
1800
2000
m_X [GeV]


16
14
12
10
8
6
4
2
0
200
400
600
800
1000
1200
1400
1600
1800
2000
m_X [GeV]

$$E[\varphi(A_u)] = \frac{1}{2}\mathrm{P}(\chi^2 > u) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{u})e^{-u/2}$$

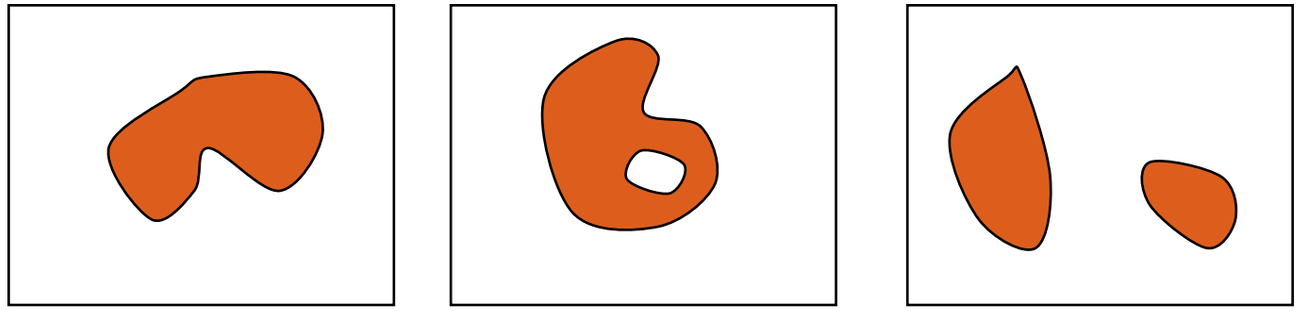


$$u = Z^2 = 3.9^2$$

$$p_{global} \sim \varphi(A_u) = \frac{1}{2}\mathrm{P}(\chi^2 > 3.9^2) + (\mathcal{N}_1 + Z\mathcal{N}_2)e^{-Z^2/2}$$

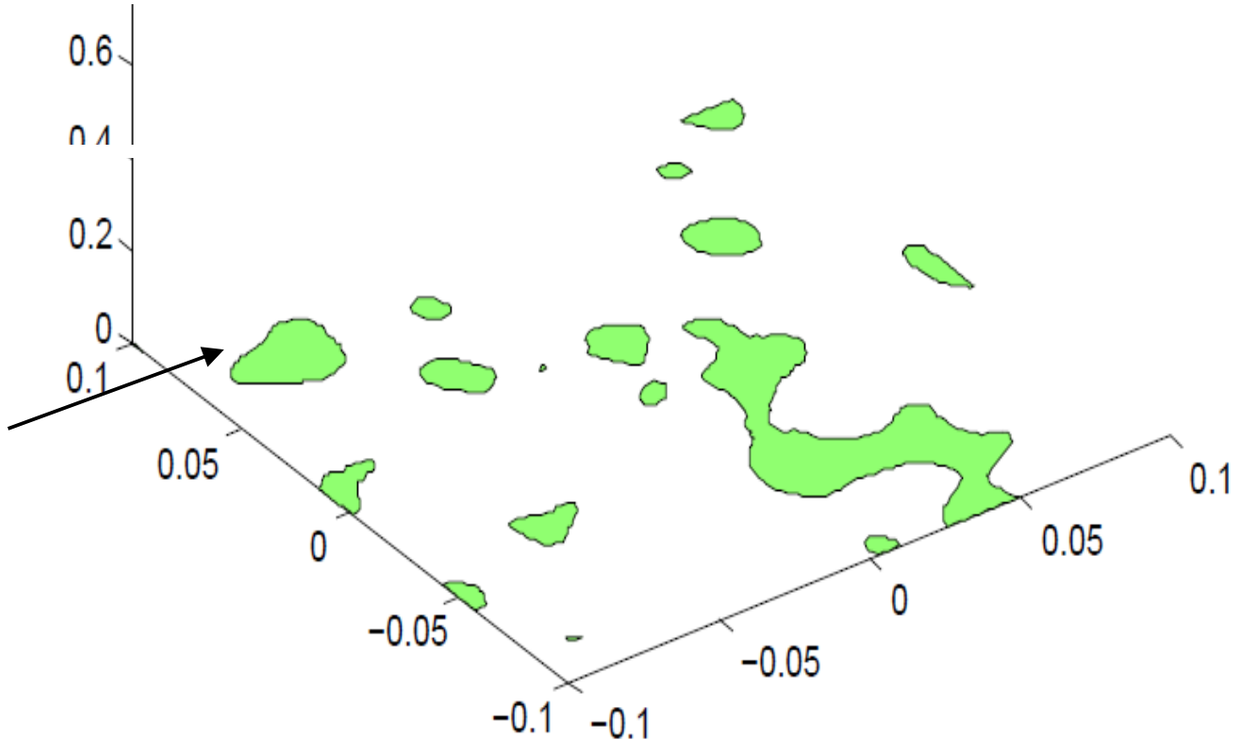
Euler Characteristic

Number of disconnected components minus number of `holes'

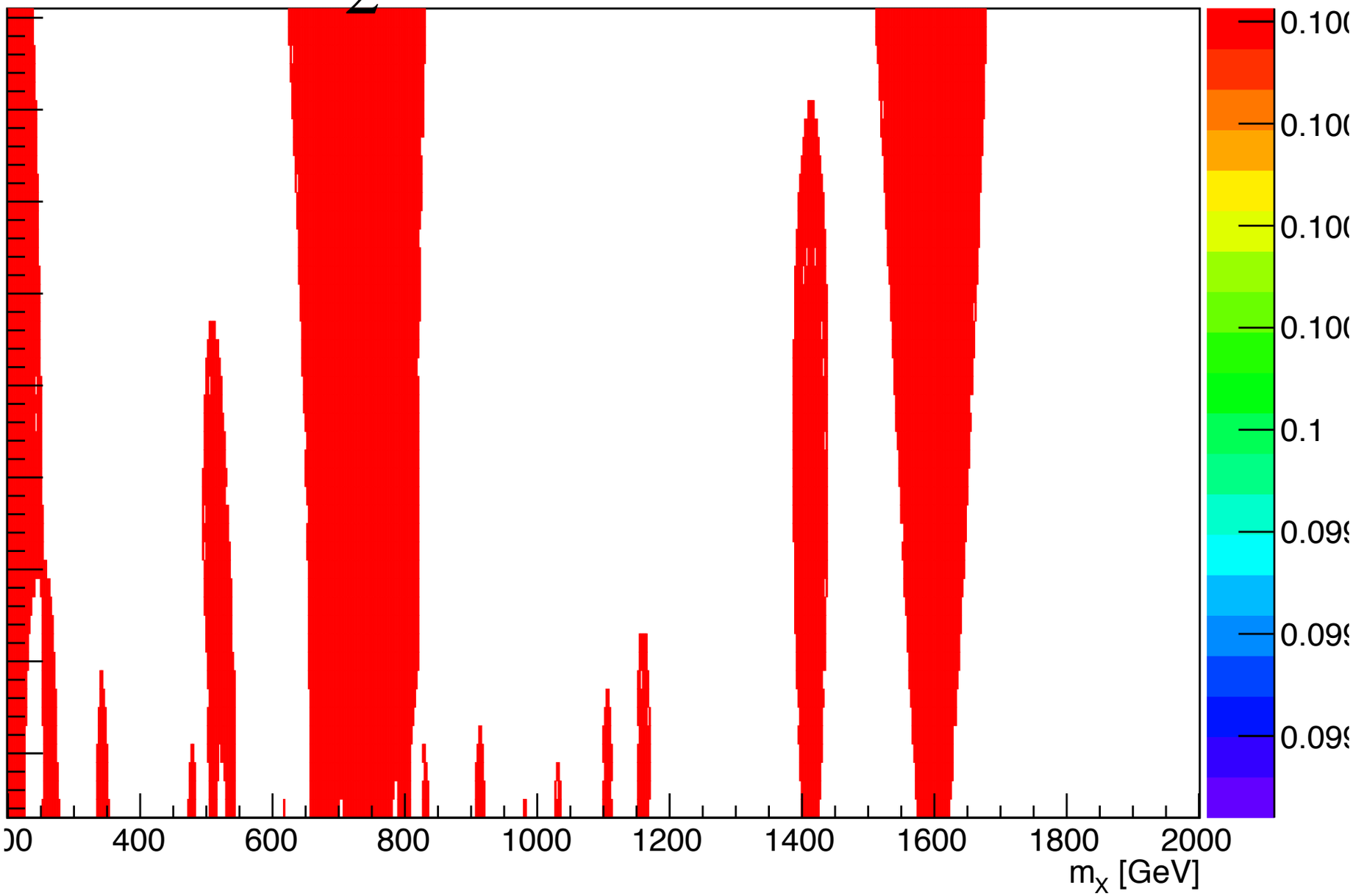


φ=1 φ=0 φ=2

Excursion set

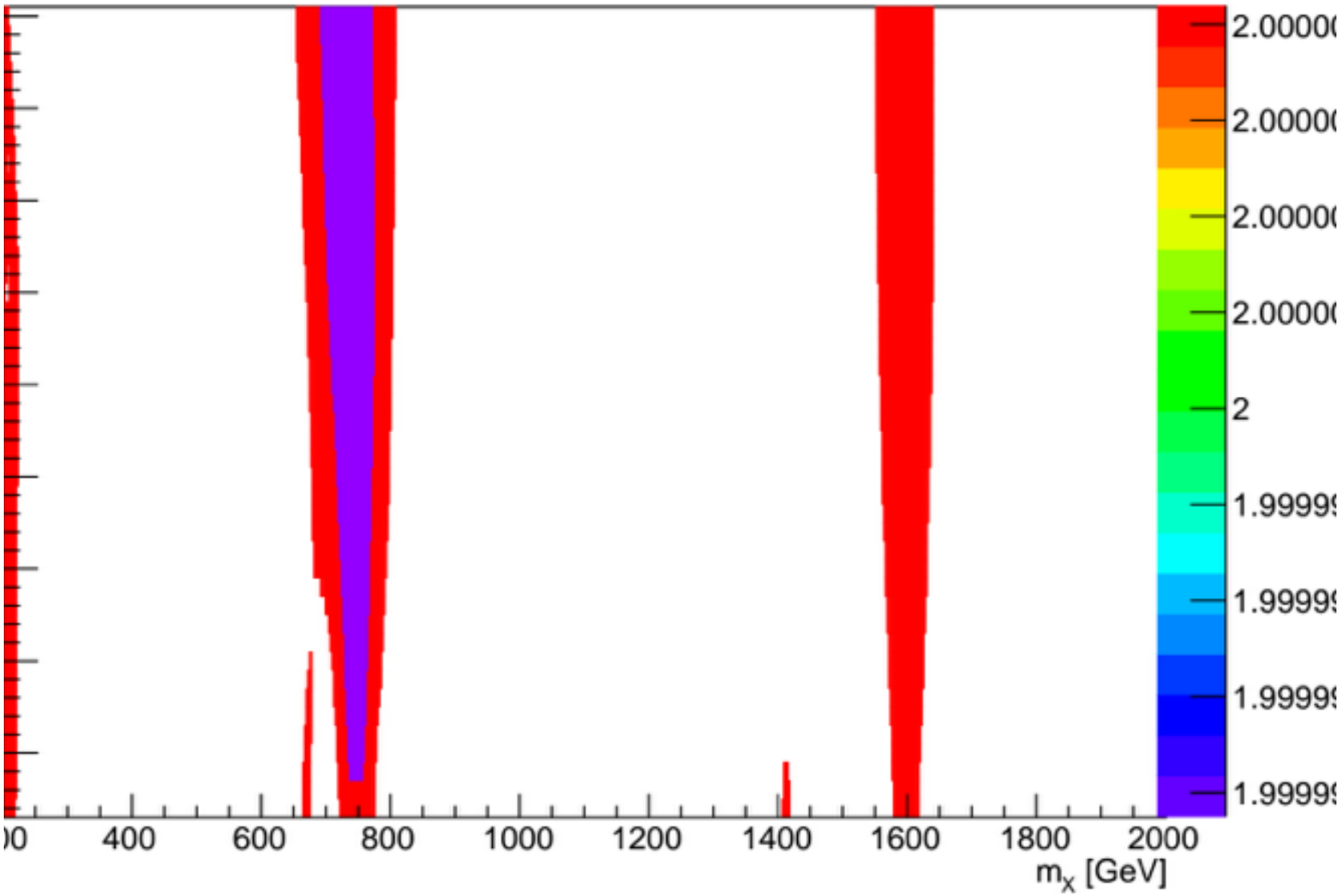


$$E[\varphi(A_u)] = \frac{1}{2}\mathrm{P}(\chi^2 > u) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{u})e^{-u/2}$$



$$13 = \frac{1}{2}\mathrm{P}(\chi^2 > 0.1) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{0.1})e^{-0.1/2}$$

$$[\varphi(A_u)] = \frac{1}{2}\mathrm{P}(\chi^2 > u) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{u})e^{-u/2}$$



$$5 = \frac{1}{2}\mathrm{P}(\chi^2 > 2) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{2})e^{-2/2}$$

$$13 = \frac{1}{2}\mathrm{P}(\chi^2 > 0.1) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{0.1})e^{-0.05}$$

$$5 = \frac{1}{2}\mathrm{P}(\chi^2 > 2) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{2})e^{-1}$$

$$p_{global} = E(\phi(15.2)) = \frac{1}{2}\mathrm{P}(\chi^2 > 15.2) + (\mathcal{N}_1 + \mathcal{N}_2\sqrt{15.2})e^{-7.6}$$

$$p_{global} = 0.00577 \Longrightarrow 2.5\sigma$$

2.5σ is not something to write home about

Interpreting the Result

Spin 2

2015

2D Scan

Largest significance

m_X ~ 750GeV, Γ_X ~ 45GeV(6%)

Local Z = 3.9σ

m=200-2000 GeV
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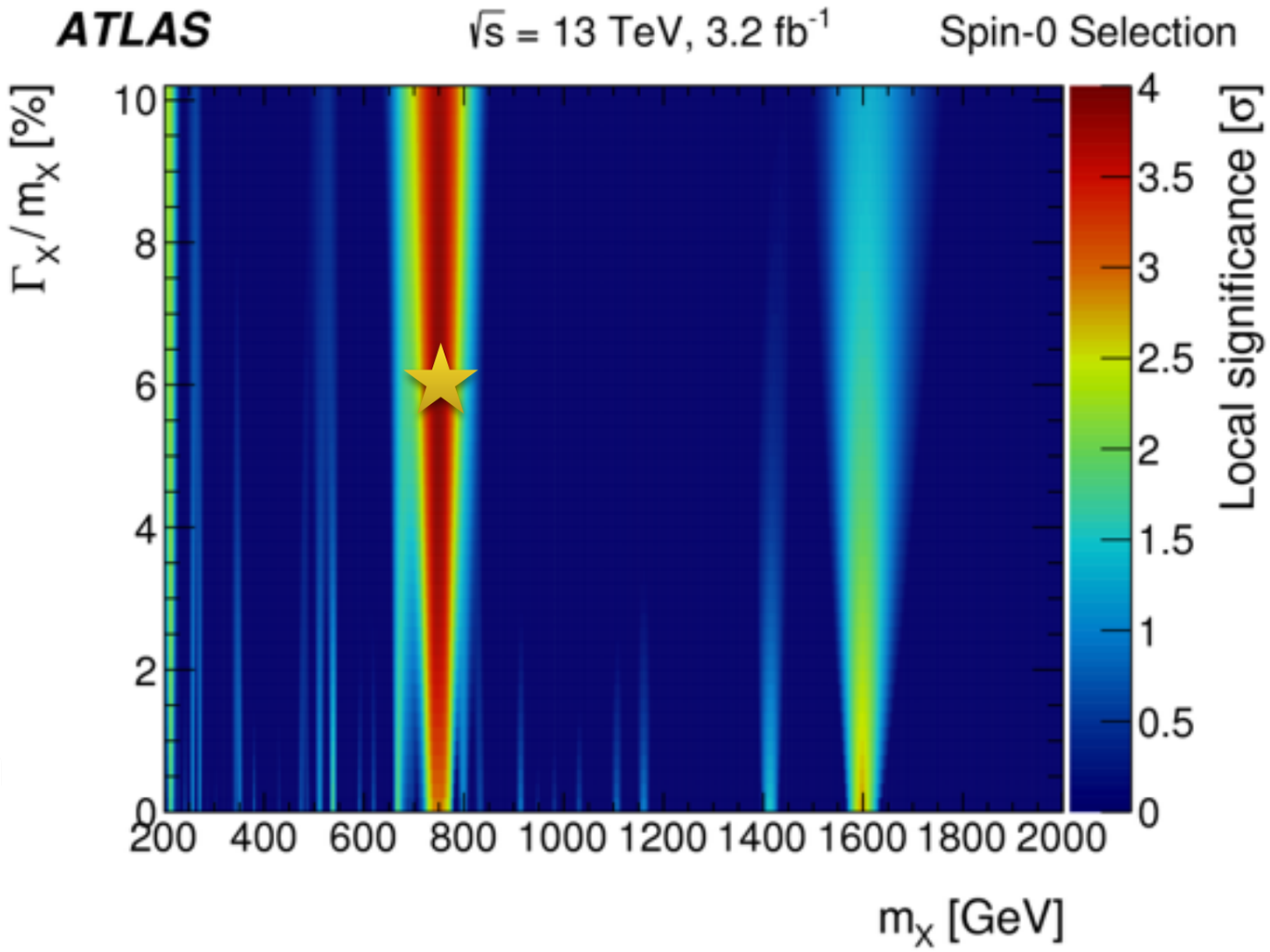

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$$Z_{local} = 3.9\sigma$$

$$Z_{global} = 2.1\sigma$$

2.1σ is not something to write home about

Some thoughts

- ATLAS drew the attention of CMS to look for a signal in a place where they have already looked and saw nothing special

- LEE 1D and 2D

- The argument of “both see it in the same place” does not work:
  There is also a LEE in answering the question: “what is the probability of BOTH experiments see it anywhere in the search mass range”

- Both did not see the same width (at all)