

Predicting and interpreting a doubly charged scalar candidate at the LHC

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Several indications for neutral scalars are observed at the LHC. One of them, a broad resonance peaked at about 650 GeV which we call H(650), was obtained by an outsider combining published histograms from ATLAS and CMS on $ZZ \rightarrow 4\ell$ searches, and this combination shows a local significance close to 4 s.d. Since then, CMS has reported two other indications at the same mass, with similar local significances: $H \rightarrow WW \rightarrow \ell\nu\ell\nu$ and $H \rightarrow bbh_{125}$ where $h_{125} \rightarrow \gamma\gamma$. ATLAS has completed its analysis of $ZZ \rightarrow 4\ell$ from which we infer an indication for H(650) with 3.5 s.d. significance. Assuming that the mass is already known from the former set, and combining these three results, one gets a global statistical significance of about 6 s.d. H(650) has a coupling to WW similar to h(125) and therefore we argue that a sum rule (SR) required by unitarity for WW implies that there should be a compensating effect from a doubly charged scalar H^{++} , with a large coupling to $W+W+$. We therefore predict that this mode should become visible through the vector boson fusion process $W+W+ \rightarrow H^{++}$, naturally provided by LHC. A recent indication for $H^{++}(450) \rightarrow W+W+$ from ATLAS allows a model independent interpretation of this result through the SR constraint which gives $BR(H^{++} \rightarrow W+W+) \sim 10\%$, implying the occurrence of additional modes $H'+W+$ and $H'+H'+$ from one or several light $H'+$ with masses below $m_{H^{++}} - m_W$ or $M_{H^{++}}/2$, that is $m_{H'+} < 370$ GeV or 225 GeV. A similar analysis is provided for $H(375) \rightarrow ZW$, indicated by ATLAS and CMS. Both channels suggest a scalar field content similar to the Georgi Machacek model with triplets, at variance with the models usually considered.

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