Borca *et al.* Reply: The preceding Comment by Zhang and Greber [1] outlines the differences in the interpretation of the field emission resonances (FERs) measured on graphene grown on Ru(0001) [2,3]. Although the experimental results are almost identical, the interpretation of the data is fundamentally different. The origin of the discrepancy is the identification of the first FER of the system. Based on a simple empirical fit to the energy positions of the different peaks, Zhang *et al.* [1] consider that the peak they observe at about +3 eV on *both* the low and high areas of the moiré superstructure is the first FER, while the peaks appearing at 4.4 eV and 4.8 eV would correspond to the quantum well state (QWS) of a potential well that they claim exists at the interface between the graphene overlayer and the Ru (0001) surface.

The peak at +3 eV cannot be the first FER state for the following reasons: (i) Contrary to the claim by Zhang and Greber, this peak is only present on the *L* areas of the moiré, something hard to reconcile with a FER ascription. In fact, it is responsible for the inversion in apparent corrugation observed in STM images recorded above +2.6 V [4]. Additionally, when the dZ/dV curves are measured using a sharp tip with better lateral resolution, there is a negligible intensity at +3 V in the *H* areas [Fig. 1(b)]. (ii) Contrary to what is expected for a FER, this peak does *not* shift in energy upon increasing the electric field between tip and sample (see Fig. 1 and supplementary information in Ref. [2]); (iii) the peak at +3 eV does not exist in *gr*/Ir(111), a system that, due to weaker interaction, does not support a interface state.

There is no evidence that the states at +4.4 (*H* areas) and +4.8 (*L* areas) eV correspond to a QWS (surprisingly located in the middle of the series of FERs), but they rather behave as FERs. Their identification as QWSs is based on the assumption by Zhang *et al.* [3] of the existence of a quantum well at the graphene/Ru(0001) interface and the fit of their energy position with a four free parameter model [3]. However, it is difficult to explain why these peaks, identified as QWSs trapped between graphene and the Ru(0001), change dramatically their energy with the electric field between tip and sample (see Fig. 1 and the

supplementary information in Ref. [2]), as a *bona fide* FER should.

Our interpretation is based on first-principles calculations and explains the origin of the peak at +3 eV as a Ru (0001) surface resonance that for clean ruthenium is at the edge of the gap at the Γ point and shifts up in energy as the graphene-Ru distance decreases (*L* areas). Simultaneously, part of its probability density moves above the graphene layer allowing its detection (Fig. 4 in Ref. [2]). Therefore, there is no electron counting problem. In the *H* areas the Ru(0001) surface resonance is around +2 eV and localized at the interface, thus giving no intensity in the dZ/dV spectrum (Fig. 1). The peaks at +4.4 eV and +4.8 eV correspond to the first FER and their energies are dictated by competing effects: (i) the modulation of the work function shifts the FERs down in energy in the *L* areas, and (ii) the combined effect of the electric field between tip and sample and the Ru-induced confinement, shifts the first FER up in energy in the *L* areas overcompensating the change in work function.

In conclusion, we believe that our interpretation is consistent with all available experimental observations and firmly supported by first-principles calculations.

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FIG. 1 (color online). dZ/dV curves measured at 4.6 K with two different tips, one blunter (a) than the other (b). The strength of the electric field between tip and sample is different as can be inferred from the number of FERs observed.

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