Title: Structure of the Galois group of the maximal unramified pro-2-extension of some \( \mathbb{Z}_2 \)-extensions

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For a number field \( k \), we consider the Galois group \( G = \text{Gal}(\mathcal{L}(k_1)/k_1) \) of the maximal unramified pro-2-extension of the cyclotomic \( \mathbb{Z}_2 \)-extension \( k_1 \) of \( k \). In terms of transfer, we establish a necessary and sufficient condition for a 2-group to be abelian or metacyclic non-abelian whenever its abelianization is of type \( (2^n, 2^m) \), with \( n \geq 2 \) and \( m \geq 2 \). Then we apply this result to construct an infinite family of real quadratic fields for which \( G \) is an abelian pro-2-group of rank 2.

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