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The observation of negative permittivity in stripe and bubble phases

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The physics of itinerant two-dimensional electrons is by and large governed by repulsive Coulomb forces. However, cases exist where the interplay of attractive and repulsive interaction components may instigate spontaneous symmetry lowering and clustering of charges in geometric patterns such as bubbles and stripes, provided these interactions act on different length scales. The existence of these phases in higher Landau levels has so far been concluded from transport behavior. Here, we report surface acoustic wave experiments. They probe the permittivity at small wave vector. This technique offers true directionality, whereas in transport the current distribution is complex and strongly affected by the inhomogeneous density pattern. Outside the charge density wave regime, the measured permittivity is always positive. However, negative permittivity is observed in the bubble phase irrespective of the propagation direction. For the stripe phase the permittivity takes on both positive as well as negative values depending on the propagation direction. This confirms the stripe phase to be a strongly anisotropic medium. The observation of negative permittivity is considered an immediate consequence of the exchange related attractive interaction. It makes charge clustering favorable in higher Landau levels where the repulsive direct Coulomb interaction acts on a longer length scale and is responsible for a negative compressibility of the electronic system. This work has been carried out with B. Friess, K. von Klitzing (MPI-FKF), Y. Peng, F. von Oppen (FU Berlin), B. Rosenow (Uni Leipzig) and V. Umansky (Weizmann Institute of Science).