$(0.5 \ x \ n)(2e^2/h) \ conductance \ steps \ observed \ in \ side-gated \ constriction \ made \ at \ In_{0.75}Ga_{0.25}As/In_{0.75}Al_{0.25}As \ heterojunction \ under \ zero-field$

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Very recently, a group of compound semiconductor heterojunctions composed of narrow-gap materials has attracted much attentions, since they often revealed high electron mobilities (<10⁶ cm²/Vsec) as well as a finite zero-field spin-splitting ($\Delta < 10 \text{ meV}$) although still at low temperatures. Those heterojunctions are interesting not only from the viewpoint of possible application toward semiconductor spintronic devices but also from that of opening a new physics area, so-called "mesoscopic spintronics". At present, however, the material system which reveals both the features at the same time islimited to InGaAs based ones such as Ino5Ga05As/Ino5Alo5As [1], In₀₇₇Ga₀₂₃As/InP [2]. and In_{0.75}Ga_{0.25}As/In_{0.75}Al_{0.25}As [3]. It is well known that the strong spin-orbit interaction in narrowgap heterojunctions often appears as a major scattering mechanism at very low temperatures. So far, anti-localization [4-6] has been discussed as a quantum effect originated from the scattering mechanism. In addition, the temperature dependence of the conductance fluctuations [7] has been discussed in quantum wires fabricated at low mobility Ino5Ga05As/Ino5Alo5As two-dimensional

electron gas (2DEG).

In this paper, we first report the conductance steps with 0.5(2e²/h) spacing observed in the quantum point-contact (QPC) made at high mobility In_{0.75}Ga_{0.25}As 1 In_{0.75}Al_{0.25}As heterojunctions [8], which has a zero-field spinsplitting of almost 10 meV. Since it is difficult to operate the split-gate structure in this heterojunction due to its narrow-gap nature, we have made a point-contact by a mesa-etched wire and finger side-gates, the top edges of them are located closely to the side of the wires. Typical wire width is $1 \sim 2 \mu$ m and the length is ranging from 30 to 250 μ m. The air-gap between the wire and gates is about 0.5~1 μ m. Figure 1 shows a schematic view of the sample structure. Conductance measurements were carried out by ac lock-in technique at 1.5 K. Figure 2 is an example of measured two-terminal conductance of the QPC. As is seen clearly, 0.5, (0.5x2), and (0.5x3) (2e²/h) steps were found to appear even under zero-magnetic field for almost all samples. In addition, ~ 0.2 (2e²/h) step was often observed.

As is formerly reported [9], application of strong parallel magnetic field to the clean QPC will evolve $(0.5 \text{ x n})(2e^2/h)$ (n: integer) conductance steps. This means that the

conductance steps of n(2e²/h) at zero-field will spin split under the strong magnetic field due to Zeeman splitting. The clean QPC is usually fabricated at GaAs/AlGaAs heterojunction which has sometimes a very high electron mobility. But that material system reveals almost no zero-field spin-splitting due to the weak spinorbit interaction. Our material system, however, has a high electron mobility as well as a very **References**

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large zero-field spin-splitting, which also could yield spin-splittings of the n ($2e^2/h$) conductance steps. Observed ($0.5 \ge n$)($2e^2/h$) steps thus could be attributed to the zero-field spin-splitting itself. The origin of the ~0.2 step is not clear at present. In the presentation, the detailed experimental results including the magnetic field dependencies will be reported.

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Fig. 1 Sample structure of finger-gate point contact. Wire width and gap between the wire and the gates are 2 and 1 μ m, respectively.



Fig. 2 Results of conductance measurements. Background resistance is different between saples, A and B.