We performed systematic observations of the H I Brα line (4.05 μm) in 51 nearby (z < 0.3) ultraluminous infrared galaxies (ULIRGs) to quantitatively estimate star formation rates (SFRs) with AKARI. The Brα line is predicted to be the brightest among the H I recombination lines in ULIRGs with visual extinction higher than 15 mag. We estimated the relative contribution of starburst to the total infrared luminosity (LIR) using the ratio of the Brα line luminosity (L_{Brα}) to L_{IR}. The L_{Brα}/L_{IR} ratio in LINERs or Seyferts is significantly lower (~50%) than that in H II galaxies. This result indicates that active galactic nuclei contribute significantly (~50%) to L_{IR} in LINERs as well as Seyferts. We also estimate the absolute contribution of starburst using the ratio of star formation rates (SFRs) derived from L_{Brα} (SFR_{Brα}) and those needed to explain L_{IR} (SFR_{IR}). The mean SFR_{Brα}/SFR_{IR} ratio is only 0.33 even in H II galaxies. We attribute this apparently low ratio to the absorption of ionizing photons by dust within H II regions. The WFIRST/AFTA grism will enable us to investigate this problem in a very large number of galaxies.