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Transcription leads to pervasive replisome instability in bacteria.

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The canonical model of DNA replication describes a highly-processive and largely continuous process by which the genome is duplicated. This continuous model is based upon *in vitro* reconstitution and *in vivo* ensemble experiments. Here, we characterize the replisome-complex stoichiometry and dynamics with single-molecule resolution in bacterial cells. Strikingly, the stoichiometries of the replicative helicase, DNA polymerase, and clamp loader complexes are consistent with the presence of only one active replisome in a significant fraction of cells (>40%). Furthermore, many of the observed complexes have short lifetimes (<8 min), suggesting that replisome disassembly is quite prevalent, possibly occurring several times per cell cycle. The instability of the replisome complex is conflict-induced: transcription inhibition stabilizes these complexes, restoring the second replisome in many of the cells. Our results suggest that, in contrast to the canonical model, DNA replication is a largely discontinuous process *in vivo* due to pervasive replication-transcription conflicts.