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Gas inflows in galaxy mergers as a key to the pairing, growth and formation of supermassive black holes

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Galaxy mergers are known to deliver a large fraction of the interstellar gas of galaxies towards the inner few hundred parsecs. The large resulting gas concentrations are of paramount importance to understand the fueling of central supermassive black holes, and may determine the conditions under which a pair of such black holes can sink and coalesce at the center of the merger remnant following a burst of gravitational waves. However, for a long time direct calculations that model the gravitational, hydrodynamical and radiative processes involved had only been able to hint qualitatively at the phenomenon of gas inflows, mostly due to their limited resolution in the nuclear region. Here I review the results of recent state-of-the art simulations performed with some of the largest parallel supercomputers available which have allowed to resolve scales of parsecs and below while the mergers of two galaxies takes place. I will show how the gas brought towards the central hundred parsecs produces a massive, star forming nuclear disk which compares well with recent observations of merger remnants in the nearby Universe. The numerical simulations demonstrate that a pair of supermassive black holes embedded in such nuclear disk can bind into binary on very short timescales, less than a million year. Whether the binary of supermassive black holes will easily be able to shrink down to the separation at which loss of energy via gravitational waves becomes the dominant process eroding its orbit is still under investigation. Moreover, in another calculation probing sub-parsec scales in the nuclear disk it is shown that more than a hundred million solar masses of gas can be transported to the inner parsec via torques driven by spiral instabilities. This strongly suggests not only that such disk torques are responsible for the fueling of supermassive black holes in galaxy mergers, but also that a massive black hole may form directly and rapidly from the collapse of a central gas cloud produced by the inflow. Direct, fast massive black hole formation may explain why bright quasars are seen to be in place already less than a billion year after the Big Bang.