**Laser cooling of the Yb3+-doped YAG crystal**

Biao Zhong\*a,, Yongqing Leia, Xuelu Duana, Jianping Yin\*a

aState Key Laboratory of Precision Spectroscopy, East China Normal University,

Shanghai 200062, P.R.China

\*Corresponding author: [biaozhong@lps.ecnu.edu.cn (B](mailto:biaozhong@lps.ecnu.edu.cn%20(B). Z); [jpyin@phy.ecnu.edu.cn](mailto:jpyin@phy.ecnu.edu.cn) (J.P.Y)

Yb:YAG crystals have the properties of large absorption bandwidth, good mechanical and thermal properties. They are especially suitable for a laser gain materials of high power optical-pumped lasers. Crystals possessing excellent laser cooling properties are ideal gain medium candidates for future high power athermal lasers. Yb:YAG crystals which have been proved to have excellent laser cooling properties in theory are suitable for the athermal laser gain medium. However, the excellent laser cooling capacity of Yb:YAG crystals have not been fully proved experimentally. Utilizing a CW fiber laser, we demonstrate that the 3% Yb3+-doped YAG single crystal reaches its unprecedented cooling temperature limit of 225.3 K from the room temperature via the anti-Stokes fluorescence. The theoretical analysis based on the experimental results predicts that the cooling temperature limit of the 3% Yb3+-doped YAG crystal can reach as low as 180 K, in particular, if one further purify the crystal and reduce its background absorption coefficient to αb = 1.0×10-4 cm-1, then the sample can be cooled to ~135 K at the wavelength of 1030 nm, which thus opening up a potential pathway to develop athermal laser of high power and the solid state optical refrigeration upon this most widely used laser material.