Appendix to the Paper:

X. Zhang and G. Ge, Existence of resolvable H-designs with group sizes $2, 3, 4$ and 6, Designs, Codes and Cryptography, to appear.

Lemma 0.1. *There exists an* $RH(4^{19})$.

Proof. In [1, Lemma 5.4], Cao, Ji and Zhu constructed an $H(2^{19})$ on Z_{38} with group set $\{\{j, j+19\}, j = 0, 1, \cdots, 18\}$ and the following shortened list of base blocks.

{0,2,16,25}	{0,2,15,24}	{0,4,10,11}	{0,4,31,32}	{0,8,20,22}	{0,8,24,26}
{1,3,17,26}	{1,3,16,25}	{1,5,11,12}	{1,5,32,33 }	{1,9,21,23}	{1,9,25,27}
{0,1,2,3}	{1,2,4,6}	{0,1,4,5}	{1,2,5,9}	{0,1,6,12}	{1,2,7,23}
{0,1,8,16}	{0,1,9,30}	{1,2,10,13}	{0,1,10,22}	{1,2,11,31}	{0,1,13,23}
{0,1,14,15}	{1,2,15,18}	{1,2,16,37}	{1,2,17,27}	{0,1,17,21}	{1,2,19,25}
{1,2,22,35}	{1,2,24,34}	{1,2,26,30}	{0,1,26,29}	{1,3,7,31}	{0,2,8,23}
{0,2,10,12}	{1,3,21,24}	{0,3,6,15}	{0,3,8,18}	{0,3,9,21}	{1,4,14,22}

Here, the blocks of the last five rows are developed by a multiplier 7 of order 3. These 90 blocks and the blocks in the first two rows form the set $\mathcal{B}'$ of all base blocks, which are developed under the automorphism group $\langle(0\ 2 \ldots 34\ 36)(1\ 3\ \ldots 35\ 37)\rangle$.

For each block $B = \{a, b, c, d\} \in \mathcal{B}'$, construct an $H(2^4)$ with group set $\{\{x, x+38\} : x \in B\}$ and block set $\mathcal{A}_B = \{\{a+38i, b+38(i+k), c+38j, d+38(j+k)\} : i, j, k \in Z_2\}$. Let $\mathcal{B} = \cup_{B\in\mathcal{B}'}\mathcal{A}_B$. It is clear that $\mathcal{B}$ is the set of base blocks of an $H(4^{19})$ on $I_{76} = \{0, 1, 2, \ldots, 75\}$ with group set $\{\{j, j+19, j+38, j+57\}, j = 0, 1, \cdots, 18\}$ and an automorphism group $\langle\alpha\rangle$, where $\alpha = (0\ 2 \ldots 34\ 36)(1\ 3 \ldots 35\ 37)(38\ 40 \ldots 72\ 74)(39\ 41 \ldots 73\ 75)$. Now, we need to show the resolution.

Note that there are several blocks in $\mathcal{B}$, each of which contains exactly one element from each cycle of α. We first list below some of these blocks, each of which gives a parallel class when developed under the automorphism group $\langle\alpha\rangle$.

$\{1, 2, 54, 75\}$	$\{1, 2, 60, 73\}$	$\{0, 1, 64, 67\}$	$\{0, 3, 44, 53\}$	$\{0, 7, 52, 59\}$
$\{0, 7, 63, 58\}$	$\{0, 7, 60, 67\}$	$\{7, 14, 74, 69\}$	$\{7, 14, 40, 55\}$	$\{0, 11, 44, 55\}$
$\{0, 11, 61, 64\}$	$\{11, 22, 51, 46\}$	$\{11, 22, 62, 65\}$	$\{0, 33, 66, 51\}$	$\{38, 39, 2, 3\}$
$\{38, 39, 9, 30\}$	$\{39, 40, 15, 18\}$	$\{39, 40, 16, 37\}$	$\{38, 39, 26, 29\}$	$\{38, 45, 14, 21\}$
$\{38, 45, 25, 20\}$	$\{45, 52, 32, 15\}$	$\{38, 45, 22, 29\}$	$\{45, 52, 29, 12\}$	$\{45, 52, 36, 31\}$
$\{45, 52, 2, 17\}$	$\{38, 45, 30, 13\}$	$\{38, 49, 22, 33\}$	$\{38, 49, 6, 17\}$	$\{38, 49, 23, 26\}$
$\{49, 60, 34, 29\}$	$\{49, 60, 14, 5\}$	$\{38, 49, 20, 15\}$	$\{38, 71, 28, 13\}$	$\{38, 1, 2, 41\}$
$\{38, 1, 4, 43\}$	$\{38, 1, 14, 53\}$	$\{38, 1, 26, 67\}$	$\{38, 3, 6, 53\}$	$\{38, 7, 14, 59\}$
$\{38, 7, 28, 73\}$	$\{38, 7, 22, 67\}$	$\{45, 14, 29, 50\}$	$\{38, 7, 30, 51\}$	$\{38, 21, 4, 67\}$
$\{38, 11, 6, 55\}$	$\{38, 11, 2, 51\}$	$\{38, 33, 28, 51\}$	$\{0, 39, 40, 3\}$	$\{0, 39, 42, 5\}$
$\{0, 39, 52, 15\}$	$\{1, 40, 53, 18\}$	$\{0, 39, 64, 29\}$	$\{0, 45, 66, 35\}$	$\{0, 45, 68, 13\}$
$\{0, 59, 42, 29\}$	$\{0, 49, 60, 33\}$	$\{0, 71, 66, 13\}$	$\{38, 1, 47, 30\}$	$\{38, 7, 63, 20\}$
$\{45, 14, 70, 15\}$	$\{45, 14, 74, 31\}$	$\{38, 11, 61, 26\}$	$\{49, 22, 72, 29\}$	$\{49, 22, 62, 27\}$
$\{0, 39, 9, 68\}$	$\{1, 40, 16, 75\}$	$\{1, 40, 22, 73\}$	$\{0, 45, 25, 58\}$	$\{7, 52, 32, 53\}$
$\{7, 52, 36, 69\}$	$\{0, 49, 23, 64\}$	$\{11, 60, 34, 67\}$	$\{11, 60, 24, 65\}$	$\{11, 60, 14, 43\}$

Then we shift each of the remaining base blocks in $\mathcal{B}$ by a suitable automorphism α^i for some integer i. The result is listed below, where the blocks in each of the four consecutive rows, namely the ith, $(i+1)$th, $(i+2)$th and $(i+3)$th rows for $i \in \{4k+1 : k = 0, 1, \ldots, 38\}$, form a parallel class.

{0, 1, 2, 3}	{5, 6, 8, 10}	{12, 13, 16, 17}	{19, 20, 23, 27}	{24, 25, 30, 36}
{31, 32, 37, 15}	{33, 34, 4, 7}	{26, 29, 35, 9}	{14, 21, 18, 22}	{38, 39, 40, 41}
{43, 44, 46, 48}	{50, 51, 54, 55}	{57, 58, 61, 65}	{62, 63, 68, 74}	{59, 60, 75, 47}
{66, 73, 42, 49}	{56, 67, 52, 70}	{45, 53, 69, 71}	{64, 28, 72, 11}	
{0, 1, 8, 16}	{2, 3, 11, 32}	{4, 5, 14, 26}	{17, 18, 27, 9}	{6, 7, 19, 29}
{20, 21, 34, 35}	{22, 23, 10, 13}	{12, 33, 30, 24}	{25, 36, 31, 37}	{39, 40, 45, 61}
{42, 43, 50, 58}	{46, 47, 55, 38}	{51, 52, 60, 63}	{65, 66, 75, 57}	{72, 73, 48, 49}
{53, 54, 67, 70}	{64, 71, 69, 59}	{41, 62, 56, 74}	{28, 68, 44, 15}	
{1, 2, 15, 18}	{5, 6, 20, 3}	{7, 8, 23, 33}	{10, 11, 27, 31}	{13, 14, 34, 9}
{37, 0, 22, 32}	{25, 26, 12, 16}	{17, 24, 21, 19}	{38, 39, 48, 60}	{40, 41, 53, 63}
{49, 50, 64, 47}	{44, 45, 61, 65}	{51, 52, 69, 75}	{73, 74, 58, 68}	{59, 66, 42, 56}
{55, 62, 67, 71}	{70, 43, 29, 35}	{46, 54, 28, 30}	{72, 36, 4, 57}	
{1, 2, 19, 25}	{3, 5, 9, 33}	{4, 6, 12, 27}	{8, 10, 18, 20}	{11, 13, 31, 34}
{14, 17, 22, 32}	{16, 23, 30, 37}	{0, 7, 28, 35}	{39, 40, 60, 73}	{41, 42, 66, 70}
{46, 47, 72, 75}	{51, 53, 57, 43}	{48, 50, 56, 71}	{61, 64, 74, 44}	{38, 49, 67, 63}
{58, 62, 68, 69}	{29, 36, 65, 59}	{52, 54, 24, 26}	{15, 55, 21, 45}	
{0, 3, 6, 15}	{1, 4, 14, 22}	{11, 18, 32, 8}	{9, 16, 37, 27}	{12, 19, 30, 10}
{26, 33, 20, 28}	{36, 5, 13, 7}	{34, 17, 21, 29}	{31, 35, 24, 25}	{38, 40, 48, 50}
{39, 41, 59, 62}	{46, 49, 52, 61}	{64, 67, 72, 44}	{54, 57, 63, 75}	{66, 73, 60, 68}
{74, 47, 42, 53}	{70, 43, 55, 58}	{45, 56, 69, 65}	{71, 2, 23, 51}	
{0, 7, 25, 20}	{9, 16, 34, 17}	{11, 18, 5, 31}	{6, 13, 28, 35}	{19, 26, 3, 24}
{23, 30, 21, 15}	{32, 1, 37, 27}	{33, 2, 4, 36}	{38, 45, 66, 73}	{47, 54, 75, 65}
{42, 49, 46, 50}	{51, 58, 55, 53}	{64, 71, 44, 62}	{60, 74, 40, 69}	{61, 63, 39, 48}
{59, 67, 41, 43}	{57, 52, 10, 22}	{56, 29, 14, 70}	{12, 72, 8, 68}	
{7, 14, 36, 31}	{9, 16, 21, 25}	{13, 20, 8, 23}	{11, 18, 34, 24}	{30, 37, 22, 5}
{15, 29, 19, 35}	{17, 0, 32, 12}	{33, 6, 4, 10}	{38, 45, 63, 58}	{47, 54, 72, 55}
{49, 56, 43, 69}	{44, 51, 59, 53}	{57, 64, 41, 62}	{73, 42, 71, 65}	{52, 66, 46, 60}
{67, 40, 70, 61}	{27, 68, 2, 48}	{26, 75, 28, 39}	{1, 50, 3, 74}	
{0, 14, 18, 9}	{2, 16, 34, 10}	{11, 25, 37, 20}	{22, 5, 26, 13}	{6, 17, 28, 1}
{24, 35, 30, 3}	{31, 4, 21, 7}	{12, 23, 32, 27}	{38, 45, 60, 67}	{49, 56, 40, 73}
{47, 54, 42, 57}	{55, 62, 64, 58}	{39, 53, 65, 48}	{61, 72, 69, 59}	{63, 74, 50, 46}
{71, 75, 43, 44}	{8, 15, 51, 41}	{19, 68, 52, 36}	{66, 29, 70, 33}	
{11, 22, 6, 28}	{2, 13, 30, 20}	{12, 23, 24, 36}	{8, 19, 31, 34}	{15, 26, 0, 33}
{18, 29, 14, 32}	{10, 21, 1, 35}	{4, 37, 27, 7}	{17, 25, 3, 5}	{45, 52, 68, 58}
{40, 47, 70, 53}	{51, 65, 55, 71}	{42, 63, 67, 75}	{43, 54, 66, 61}	{38, 60, 72, 56}
{57, 41, 49, 44}	{74, 69, 59, 39}	{48, 50, 64, 73}	{46, 9, 16, 62}	
{11, 22, 7, 37}	{2, 13, 4, 15}	{17, 28, 19, 14}	{23, 34, 36, 1}	{5, 16, 29, 25}
{24, 35, 21, 27}	{33, 6, 3, 31}	{10, 18, 30, 32}	{38, 59, 42, 67}	{40, 61, 58, 52}
{44, 55, 66, 39}	{51, 62, 46, 68}	{53, 64, 49, 41}	{60, 71, 57, 63}	{54, 65, 74, 69}
{70, 72, 47, 56}	{9, 20, 43, 73}	{45, 8, 48, 12}	{26, 75, 0, 50}	
{11, 22, 14, 5}	{13, 24, 0, 34}	{19, 3, 9, 7}	{4, 26, 16, 29}	{10, 32, 6, 28}
{31, 15, 23, 18}	{17, 12, 8, 20}	{49, 60, 55, 61}	{40, 51, 68, 58}	{53, 64, 43, 67}
{62, 73, 74, 48}	{52, 63, 54, 65}	{59, 70, 72, 75}	{57, 41, 47, 45}	{56, 39, 36, 30}
{38, 21, 25, 71}	{27, 66, 69, 35}	{37, 44, 46, 2}	{1, 50, 42, 33}	
{0, 33, 28, 13}	{2, 35, 14, 10}	{4, 6, 20, 29}	{22, 24, 37, 8}	{32, 36, 25, 26}
{5, 7, 21, 30}	{19, 27, 1, 3}	{49, 60, 51, 46}	{53, 64, 62, 68}	{44, 66, 56, 69}
{42, 75, 70, 55}	{40, 73, 52, 48}	{50, 58, 74, 38}	{39, 41, 54, 63}	{17, 18, 65, 47}
{12, 15, 59, 71}	{61, 34, 9, 43}	{23, 72, 57, 11}	{67, 31, 45, 16}	
{0, 4, 10, 11}	{6, 14, 30, 32}	{1, 3, 16, 25}	{9, 13, 19, 20}	{49, 44, 40, 52}
{38, 42, 69, 70}	{46, 54, 66, 68}	{41, 45, 72, 73}	{7, 8, 48, 50}	{17, 18, 59, 63}
{21, 22, 65, 43}	{34, 35, 47, 57}	{5, 12, 71, 61}	{33, 28, 62, 74}	{29, 37, 53, 55}
{51, 58, 36, 26}	{39, 23, 31, 64}	{67, 2, 75, 27}	{15, 60, 24, 56}	
{0, 1, 44, 50}	{2, 3, 48, 56}	{4, 5, 52, 64}	{7, 8, 61, 71}	{10, 11, 65, 69}

$\{17, 18, 73, 41\}$	$\{13, 14, 74, 46\}$	$\{29, 30, 54, 58\}$	$\{19, 21, 63, 49\}$	$\{20, 22, 66, 43\}$
$\{24, 27, 70, 42\}$	$\{9, 12, 60, 68\}$	$\{25, 32, 57, 45\}$	$\{53, 16, 33, 39\}$	$\{37, 38, 55, 23\}$
$\{6, 51, 59, 15\}$	$\{62, 26, 72, 36\}$	$\{47, 31, 75, 35\}$	$\{28, 67, 34, 40\}$	
$\{0, 2, 48, 50\}$	$\{1, 3, 59, 62\}$	$\{7, 14, 66, 42\}$	$\{10, 17, 52, 56\}$	$\{9, 16, 51, 49\}$
$\{4, 11, 60, 40\}$	$\{6, 13, 38, 46\}$	$\{8, 15, 61, 55\}$	$\{19, 26, 69, 73\}$	$\{23, 30, 70, 64\}$
$\{21, 28, 44, 72\}$	$\{18, 32, 74, 65\}$	$\{12, 33, 75, 45\}$	$\{57, 58, 37, 5\}$	$\{29, 68, 54, 20\}$
$\{27, 41, 53, 36\}$	$\{71, 35, 39, 25\}$	$\{22, 63, 31, 43\}$	$\{34, 67, 24, 47\}$	
$\{7, 21, 49, 65\}$	$\{0, 14, 70, 46\}$	$\{9, 23, 73, 56\}$	$\{4, 25, 60, 54\}$	$\{11, 32, 64, 44\}$
$\{17, 28, 50, 72\}$	$\{13, 24, 57, 63\}$	$\{20, 31, 48, 38\}$	$\{15, 26, 43, 67\}$	$\{16, 27, 66, 40\}$
$\{8, 19, 75, 71\}$	$\{18, 29, 53, 59\}$	$\{30, 34, 61, 62\}$	$\{45, 52, 5, 37\}$	$\{74, 47, 10, 22\}$
$\{68, 33, 1, 51\}$	$\{69, 35, 3, 42\}$	$\{39, 12, 41, 36\}$	$\{6, 55, 2, 58\}$	
$\{0, 11, 72, 52\}$	$\{13, 24, 75, 71\}$	$\{15, 26, 61, 51\}$	$\{17, 28, 42, 38\}$	$\{21, 32, 68, 74\}$
$\{19, 3, 47, 45\}$	$\{14, 36, 64, 39\}$	$\{22, 6, 56, 40\}$	$\{23, 7, 53, 48\}$	$\{4, 37, 54, 50\}$
$\{2, 35, 63, 43\}$	$\{16, 18, 70, 41\}$	$\{59, 60, 25, 29\}$	$\{65, 67, 9, 12\}$	$\{62, 69, 1, 33\}$
$\{58, 31, 5, 46\}$	$\{57, 30, 27, 55\}$	$\{20, 66, 44, 8\}$	$\{34, 73, 10, 49\}$	
$\{0, 2, 53, 62\}$	$\{6, 10, 54, 55\}$	$\{8, 16, 66, 68\}$	$\{12, 20, 74, 38\}$	$\{7, 9, 61, 70\}$
$\{3, 5, 56, 65\}$	$\{11, 15, 59, 60\}$	$\{13, 17, 44, 45\}$	$\{19, 27, 39, 41\}$	$\{57, 58, 22, 24\}$
$\{48, 49, 18, 26\}$	$\{46, 47, 21, 31\}$	$\{51, 52, 29, 1\}$	$\{67, 32, 4, 50\}$	$\{64, 33, 30, 72\}$
$\{40, 35, 25, 43\}$	$\{34, 75, 42, 14\}$	$\{28, 73, 71, 23\}$	$\{63, 36, 69, 37\}$	
$\{38, 39, 6, 12\}$	$\{41, 42, 9, 25\}$	$\{44, 45, 16, 28\}$	$\{47, 48, 19, 1\}$	$\{50, 51, 29, 33\}$
$\{53, 54, 0, 10\}$	$\{55, 56, 4, 8\}$	$\{59, 61, 27, 13\}$	$\{60, 62, 30, 7\}$	$\{40, 43, 11, 23\}$
$\{49, 52, 24, 32\}$	$\{63, 70, 15, 5\}$	$\{64, 71, 31, 21\}$	$\{73, 37, 3, 65\}$	$\{58, 34, 14, 66\}$
$\{69, 26, 22, 72\}$	$\{17, 57, 75, 2\}$	$\{18, 67, 46, 36\}$	$\{35, 74, 20, 68\}$	
$\{38, 41, 8, 18\}$	$\{45, 52, 28, 4\}$	$\{40, 47, 6, 10\}$	$\{49, 56, 15, 13\}$	$\{54, 61, 34, 14\}$
$\{60, 67, 16, 24\}$	$\{51, 58, 7, 33\}$	$\{57, 64, 31, 35\}$	$\{55, 62, 26, 20\}$	$\{59, 73, 25, 3\}$
$\{66, 42, 22, 36\}$	$\{70, 53, 19, 27\}$	$\{39, 50, 9, 37\}$	$\{29, 43, 71, 11\}$	$\{12, 72, 46, 30\}$
$\{32, 65, 44, 2\}$	$\{74, 5, 68, 0\}$	$\{17, 69, 21, 75\}$	$\{23, 63, 1, 48\}$	
$\{38, 52, 18, 9\}$	$\{45, 59, 33, 16\}$	$\{47, 68, 24, 4\}$	$\{49, 60, 6, 28\}$	$\{51, 62, 19, 25\}$
$\{42, 53, 32, 22\}$	$\{55, 66, 7, 31\}$	$\{50, 61, 8, 26\}$	$\{63, 74, 21, 13\}$	$\{67, 40, 15, 11\}$
$\{43, 54, 14, 20\}$	$\{56, 58, 34, 5\}$	$\{65, 69, 37, 0\}$	$\{41, 10, 1, 71\}$	$\{64, 30, 36, 75\}$
$\{17, 57, 70, 3\}$	$\{44, 27, 48, 35\}$	$\{46, 12, 39, 2\}$	$\{23, 72, 29, 73\}$	
$\{38, 49, 29, 25\}$	$\{51, 62, 0, 34\}$	$\{53, 75, 5, 3\}$	$\{44, 66, 18, 31\}$	$\{46, 68, 4, 26\}$
$\{57, 41, 11, 6\}$	$\{40, 73, 14, 10\}$	$\{48, 43, 33, 13\}$	$\{50, 52, 27, 36\}$	$\{60, 64, 15, 16\}$
$\{72, 42, 20, 22\}$	$\{45, 47, 23, 32\}$	$\{69, 71, 8, 17\}$	$\{67, 30, 1, 59\}$	$\{56, 19, 35, 39\}$
$\{24, 63, 70, 2\}$	$\{74, 12, 54, 7\}$	$\{55, 21, 65, 28\}$	$\{9, 58, 37, 61\}$	
$\{38, 42, 10, 11\}$	$\{39, 43, 32, 33\}$	$\{41, 49, 23, 25\}$	$\{51, 59, 37, 1\}$	$\{53, 16, 18, 58\}$
$\{61, 24, 27, 69\}$	$\{40, 3, 8, 52\}$	$\{63, 26, 31, 47\}$	$\{44, 7, 15, 74\}$	$\{71, 34, 4, 45\}$
$\{50, 13, 22, 72\}$	$\{75, 0, 14, 73\}$	$\{48, 17, 35, 68\}$	$\{20, 65, 62, 28\}$	$\{21, 66, 46, 29\}$
$\{6, 55, 56, 30\}$	$\{67, 36, 57, 9\}$	$\{70, 5, 60, 12\}$	$\{19, 64, 2, 54\}$	
$\{38, 1, 13, 61\}$	$\{39, 2, 17, 65\}$	$\{41, 4, 24, 75\}$	$\{45, 8, 30, 40\}$	$\{51, 14, 0, 42\}$
$\{46, 10, 18, 58\}$	$\{43, 7, 25, 66\}$	$\{50, 15, 20, 68\}$	$\{67, 36, 12, 64\}$	$\{53, 22, 19, 55\}$
$\{54, 23, 34, 52\}$	$\{63, 32, 16, 49\}$	$\{57, 26, 31, 73\}$	$\{3, 74, 70, 6\}$	$\{62, 28, 72, 35\}$
$\{21, 60, 37, 47\}$	$\{9, 48, 27, 71\}$	$\{11, 56, 5, 69\}$	$\{33, 44, 29, 59\}$	
$\{45, 14, 32, 53\}$	$\{40, 9, 34, 42\}$	$\{47, 16, 3, 67\}$	$\{46, 15, 23, 55\}$	$\{38, 7, 5, 71\}$
$\{49, 18, 6, 59\}$	$\{51, 20, 22, 54\}$	$\{57, 26, 4, 70\}$	$\{61, 37, 27, 43\}$	$\{60, 36, 2, 69\}$
$\{63, 1, 13, 72\}$	$\{65, 0, 33, 39\}$	$\{29, 68, 50, 25\}$	$\{11, 56, 44, 21\}$	$\{10, 62, 66, 19\}$
$\{28, 74, 48, 12\}$	$\{35, 75, 17, 58\}$	$\{31, 52, 8, 64\}$	$\{24, 73, 30, 41\}$	
$\{38, 21, 18, 50\}$	$\{45, 28, 22, 40\}$	$\{51, 24, 8, 68\}$	$\{42, 15, 32, 60\}$	$\{53, 26, 5, 67\}$
$\{46, 19, 20, 70\}$	$\{57, 30, 4, 75\}$	$\{71, 6, 29, 59\}$	$\{44, 17, 35, 69\}$	$\{61, 34, 36, 39\}$
$\{52, 25, 11, 55\}$	$\{43, 16, 14, 58\}$	$\{13, 73, 41, 1\}$	$\{49, 12, 65, 37\}$	$\{47, 10, 72, 0\}$
$\{54, 27, 74, 31\}$	$\{9, 48, 23, 64\}$	$\{7, 56, 2, 62\}$	$\{3, 63, 33, 66\}$	
$\{49, 22, 14, 43\}$	$\{51, 24, 0, 72\}$	$\{53, 37, 5, 41\}$	$\{42, 26, 16, 67\}$	$\{44, 28, 2, 62\}$
$\{38, 33, 12, 46\}$	$\{40, 4, 18, 65\}$	$\{68, 32, 7, 54\}$	$\{64, 30, 19, 58\}$	$\{66, 36, 10, 50\}$
$\{45, 9, 23, 70\}$	$\{21, 60, 69, 13\}$	$\{20, 59, 75, 3\}$	$\{29, 74, 71, 31\}$	$\{34, 55, 52, 8\}$
$\{1, 47, 63, 27\}$	$\{73, 11, 39, 17\}$	$\{35, 57, 25, 61\}$	$\{15, 48, 6, 56\}$	
$\{38, 8, 24, 64\}$	$\{39, 3, 16, 63\}$	$\{41, 7, 34, 73\}$	$\{43, 13, 25, 65\}$	$\{45, 15, 31, 71\}$
$\{1, 40, 42, 6\}$	$\{10, 49, 54, 22\}$	$\{11, 50, 55, 33\}$	$\{12, 51, 59, 4\}$	$\{5, 44, 52, 17\}$
$\{18, 57, 66, 2\}$	$\{21, 60, 74, 19\}$	$\{37, 48, 46, 14\}$	$\{58, 27, 62, 28\}$	$\{29, 68, 32, 72\}$

{30, 70, 0, 53}	{9, 61, 35, 56}	{36, 47, 20, 69}	{26, 75, 23, 67}	
{0, 39, 51, 23}	{1, 40, 55, 27}	{3, 42, 64, 36}	{5, 45, 49, 35}	{6, 46, 52, 29}
{8, 48, 56, 20}	{12, 53, 59, 33}	{9, 50, 60, 30}	{13, 58, 72, 10}	{18, 63, 74, 16}
{32, 43, 61, 19}	{66, 31, 75, 11}	{68, 37, 73, 25}	{26, 65, 28, 67}	{15, 54, 2, 44}
{17, 62, 21, 57}	{34, 41, 14, 70}	{24, 38, 4, 71}	{7, 47, 22, 69}	
{7, 52, 73, 25}	{0, 45, 63, 20}	{2, 47, 72, 4}	{9, 54, 41, 29}	{11, 56, 40, 35}
{13, 58, 49, 5}	{15, 60, 65, 31}	{19, 64, 42, 32}	{14, 66, 46, 22}	{17, 38, 70, 12}
{53, 16, 57, 23}	{74, 37, 62, 27}	{39, 8, 43, 3}	{50, 33, 68, 24}	{61, 34, 48, 6}
{51, 21, 75, 1}	{28, 67, 36, 44}	{30, 69, 18, 59}	{26, 71, 10, 55}	
{0, 59, 63, 33}	{11, 60, 55, 23}	{13, 62, 41, 27}	{4, 53, 65, 30}	{17, 66, 40, 35}
{2, 51, 74, 16}	{21, 70, 72, 37}	{19, 68, 43, 1}	{12, 61, 47, 15}	{31, 42, 56, 14}
{34, 38, 44, 7}	{46, 9, 52, 20}	{67, 36, 50, 26}	{39, 3, 54, 25}	{6, 45, 10, 49}
{8, 48, 18, 58}	{28, 73, 5, 75}	{24, 69, 29, 57}	{22, 64, 32, 71}	
{11, 60, 57, 9}	{2, 62, 52, 27}	{13, 73, 43, 0}	{4, 75, 65, 7}	{6, 46, 59, 30}
{14, 56, 45, 8}	{1, 41, 55, 26}	{5, 47, 53, 16}	{3, 49, 61, 25}	{66, 29, 68, 31}
{71, 34, 51, 19}	{42, 15, 54, 28}	{74, 20, 48, 23}	{18, 63, 22, 64}	{33, 40, 17, 38}
{37, 44, 35, 67}	{36, 69, 21, 39}	{12, 58, 32, 72}	{24, 70, 10, 50}	
{1, 43, 70, 33}	{39, 2, 45, 23}	{40, 3, 48, 18}	{42, 5, 52, 26}	{53, 16, 63, 7}
{46, 9, 59, 31}	{50, 13, 64, 27}	{71, 34, 47, 12}	{51, 14, 74, 8}	{73, 4, 58, 10}
{38, 11, 44, 17}	{55, 28, 41, 37}	{75, 21, 67, 24}	{65, 22, 56, 30}	{72, 36, 49, 20}
{69, 35, 62, 25}	{15, 60, 0, 66}	{32, 54, 6, 57}	{19, 61, 29, 68}	
{38, 1, 55, 21}	{39, 3, 59, 24}	{40, 5, 46, 17}	{42, 7, 50, 22}	{43, 8, 56, 26}
{44, 13, 58, 27}	{64, 33, 54, 23}	{68, 37, 48, 28}	{47, 16, 41, 29}	{45, 14, 67, 12}
{71, 2, 69, 25}	{57, 30, 52, 36}	{62, 35, 53, 11}	{61, 34, 70, 0}	{6, 65, 10, 73}
{31, 4, 72, 63}	{66, 49, 32, 19}	{74, 9, 18, 51}	{15, 60, 75, 20}	
{38, 7, 53, 9}	{42, 11, 64, 33}	{45, 14, 57, 23}	{47, 16, 56, 12}	{44, 13, 74, 19}
{52, 28, 46, 22}	{49, 25, 75, 20}	{48, 31, 73, 5}	{51, 34, 66, 8}	{65, 0, 55, 3}
{54, 27, 50, 30}	{2, 41, 15, 63}	{32, 39, 26, 72}	{10, 21, 70, 43}	{18, 29, 58, 69}
{59, 60, 4, 17}	{61, 24, 37, 40}	{71, 6, 35, 68}	{67, 36, 62, 1}	
{38, 11, 60, 33}	{49, 22, 45, 37}	{40, 13, 42, 15}	{44, 17, 41, 9}	{50, 34, 46, 30}
{64, 21, 54, 1}	{62, 19, 74, 32}	{66, 23, 51, 31}	{56, 20, 72, 5}	{8, 47, 18, 68}
{12, 57, 26, 71}	{10, 55, 2, 61}	{4, 63, 29, 75}	{16, 65, 36, 69}	{35, 39, 28, 67}
{7, 14, 70, 53}	{6, 27, 48, 73}	{58, 59, 24, 25}	{3, 52, 43, 0}	
{38, 8, 58, 22}	{40, 10, 64, 28}	{39, 9, 59, 23}	{3, 42, 7, 49}	{5, 44, 11, 65}
{15, 54, 25, 45}	{2, 41, 19, 61}	{14, 55, 20, 67}	{16, 57, 24, 72}	{17, 62, 29, 71}
{0, 52, 32, 46}	{26, 27, 68, 69}	{33, 34, 47, 50}	{30, 37, 60, 43}	{74, 75, 12, 13}
{18, 63, 70, 1}	{6, 51, 66, 35}	{4, 53, 48, 21}	{73, 36, 56, 31}	
{0, 45, 28, 73}	{7, 52, 35, 63}	{6, 65, 24, 56}	{2, 51, 30, 58}	{4, 53, 33, 67}
{13, 62, 37, 71}	{11, 60, 19, 47}	{21, 70, 8, 42}	{23, 72, 32, 38}	{26, 27, 40, 41}
{5, 16, 66, 61}	{43, 44, 14, 17}	{54, 57, 22, 31}	{39, 50, 3, 36}	{75, 48, 12, 15}
{74, 9, 20, 69}	{10, 59, 68, 25}	{55, 18, 64, 29}	{1, 46, 34, 49}	
{0, 71, 12, 46}	{2, 42, 18, 65}	{4, 44, 19, 66}	{6, 48, 37, 38}	{1, 47, 21, 61}
{3, 49, 27, 67}	{10, 11, 50, 51}	{22, 23, 69, 52}	{7, 8, 54, 57}	{28, 35, 56, 63}
{17, 24, 39, 60}	{20, 31, 40, 73}	{74, 43, 26, 33}	{72, 45, 36, 9}	{14, 55, 58, 29}
{30, 41, 70, 5}	{53, 16, 68, 13}	{59, 32, 62, 15}	{25, 64, 34, 75}	

□

Lemma 0.2. *There exists an RH*(4^{41}).

Proof. In [1, Lemma 5.2], Cao, Ji and Zhu constructed an H(2^{41}) on Z_{82} with group set $\{\{j, j+41\}, j = 0, 1, \cdots, 40\}$ and the following shortened list of base blocks, which are developed by the automorphism group $\langle \alpha', \beta' \rangle$, where $\alpha' = (0\ 1 \ldots 80\ 81)$ and β' is a multiplier 37 of order 5 in Z_{82}.

$\mathcal{B}'$:	{0,1,2,4}	{0,1,5,6}	{0,1,7,8}	{0,1,9,10}	{0,1,11,12}	{0,1,13,14}
	{0,1,15,16}	{0,1,17,18}	{0,1,19,20}	{0,1,21,22}	{0,1,23,24}	{0,1,27,28}
	{0,1,29,30}	{0,1,31,32}	{0,1,33,34}	{0,1,35,36}	{0,1,39,43}	{0,1,40,80}
	{0,1,44,79}	{0,2,5,7}	{0,2,6,8}	{0,2,9,12}	{0,2,10,13}	{0,2,11,15}

{0,2,14,16}	{0,2,17,19}	{0,2,18,24}	{0,2,20,48}	{0,2,21,26}	{0,2,28,46}
{0,2,29,50}	{0,2,30,72}	{0,2,32,58}	{0,2,35,49}	{0,2,55,66}	{0,2,56,69}
{0,2,63,75}	{0,3,7,22}	{0,3,9,56}	{0,3,12,64}	{0,3,15,70}	{0,3,17,61}
{0,3,19,29}	{0,3,24,52}	{0,3,27,76}	{0,3,33,55}	{0,3,43,58}	{0,4,9,72}
{0,4,10,58}	{0,4,14,38}	{0,4,39,77}	{0,4,48,65}		

For each block $B = \{a,b,c,d\} \in \mathcal{B}'$, construct an $\mathrm{H}(2^4)$ with group set $\{\{x, x+82\} : x \in B\}$ and block set $\mathcal{A}_B = \{\{a+82i, b+82(i+k), c+82j, d+82(j+k)\} : i,j,k \in Z_2\}$. Let $\mathcal{B} = \cup_{B\in\mathcal{B}'}\mathcal{A}_B$. It is clear that $\mathcal{B}$ is the set of base blocks of an $\mathrm{H}(4^{41})$ on $I_{164} = \{0,1,2,\ldots,163\}$ with group set $\mathcal{G} = \{\{j, j+41, j+82, j+123\}, j = 0,1,\cdots,40\}$ and an automorphism group $\langle\alpha,\beta\rangle$, where

$$\alpha = (0\ 1 \ldots 80\ 81)(82\ 83 \ldots 162\ 163) \text{ and}$$

$$\beta = \begin{cases} \beta'(x), & \text{if } x < 82, \\ \beta'(x-82)+82, & \text{if } x \geq 82. \end{cases}$$

Now, we need to show the resolution.

Note that there are several blocks in $\mathcal{B}$, each of which contains exactly one even and one odd elements from each cycle of α. We first list below some of these blocks, each of which gives a parallel class when developed under the automorphism group $\langle\alpha^2,\beta\rangle$.

{0, 1, 87, 88}	{0, 1, 93, 94}	{0, 1, 101, 102}	{0, 1, 103, 104}	{0, 1, 105, 106}
{0, 1, 109, 110}	{0, 1, 111, 112}	{0, 1, 113, 114}	{0, 1, 115, 116}	{0, 1, 117, 118}
{0, 1, 126, 161}	{0, 3, 91, 138}	{0, 3, 97, 152}	{0, 3, 125, 140}	{82, 83, 5, 6}
{82, 83, 7, 8}	{82, 83, 9, 10}	{82, 83, 11, 12}	{82, 83, 13, 14}	{82, 83, 15, 16}
{82, 83, 17, 18}	{82, 83, 19, 20}	{82, 83, 21, 22}	{82, 83, 23, 24}	{82, 83, 27, 28}
{82, 83, 29, 30}	{82, 83, 31, 32}	{82, 83, 33, 34}	{82, 83, 35, 36}	{82, 85, 9, 56}
{82, 85, 15, 70}	{82, 85, 43, 58}	{82, 1, 44, 161}	{82, 2, 5, 89}	{82, 2, 17, 101}
{82, 2, 35, 131}	{82, 4, 39, 159}	{0, 83, 126, 79}	{0, 84, 99, 19}	{0, 84, 117, 49}
{0, 84, 145, 75}	{0, 85, 9, 138}	{0, 85, 27, 158}	{0, 85, 43, 140}	{82, 1, 87, 6}
{82, 1, 89, 8}	{82, 1, 91, 10}	{82, 1, 93, 12}	{82, 1, 97, 16}	{82, 1, 101, 20}
{82, 1, 105, 24}	{82, 1, 109, 28}	{82, 1, 111, 30}	{82, 1, 113, 32}	{82, 1, 115, 34}
{82, 1, 117, 36}	{82, 2, 87, 7}	{82, 2, 93, 15}	{82, 2, 99, 19}	{82, 2, 117, 49}
{82, 2, 145, 75}	{82, 3, 89, 22}	{82, 3, 91, 56}	{82, 3, 97, 70}	{82, 3, 125, 58}
{82, 4, 121, 77}	{0, 83, 5, 88}	{0, 83, 7, 90}	{0, 83, 9, 92}	{0, 83, 11, 94}
{0, 83, 13, 96}	{0, 83, 15, 98}	{0, 83, 17, 100}	{0, 83, 19, 102}	{0, 83, 23, 106}
{0, 83, 27, 110}	{0, 83, 29, 112}	{0, 83, 31, 114}	{0, 83, 33, 116}	{0, 83, 35, 118}
{0, 84, 5, 89}	{0, 84, 11, 97}	{0, 84, 17, 101}	{0, 84, 63, 157}	{0, 85, 7, 104}
{0, 1, 89, 90}	{0, 1, 95, 96}	{0, 1, 97, 98}		

Then we shift each of the remaining base blocks in $\mathcal{B}$ by a suitable automorphism $\alpha^i\beta^j$ for some integers i and j. The result is listed below, where the blocks in each of the eleven consecutive rows, namely the ith, $(i+1)$th, …, and $(i+10)$th rows for $i \in \{11k+1 : k = 0,1,\ldots,7\}$, form a parallel class.

{0, 1, 2, 4}	{5, 6, 10, 11}	{7, 8, 14, 15}	{12, 13, 21, 22}
{16, 17, 27, 28}	{18, 19, 31, 32}	{23, 24, 38, 39}	{25, 26, 42, 43}
{29, 30, 48, 49}	{33, 34, 54, 55}	{35, 36, 58, 59}	{40, 41, 67, 68}
{44, 45, 73, 74}	{46, 47, 77, 78}	{81, 56, 76, 51}	{60, 37, 75, 52}
{20, 57, 69, 53}	{64, 66, 70, 72}	{61, 63, 79, 3}	{82, 83, 84, 86}
{87, 88, 92, 93}	{89, 90, 96, 97}	{94, 95, 103, 104}	{98, 99, 109, 110}
{100, 101, 113, 114}	{105, 106, 120, 121}	{107, 108, 124, 125}	{111, 112, 130, 131}
{115, 116, 136, 137}	{117, 118, 140, 141}	{122, 123, 149, 150}	{126, 127, 155, 156}
{128, 129, 159, 160}	{162, 139, 85, 157}	{153, 145, 138, 135}	{144, 147, 163, 91}

{158, 161, 119, 134} {142, 146, 151, 132} {65, 148, 152, 71} {50, 133, 143, 62}
{80, 154, 102, 9}
{0, 1, 40, 80} {2, 3, 46, 81} {4, 6, 9, 11} {5, 7, 14, 17}
{8, 10, 18, 21} {13, 15, 24, 28} {20, 22, 34, 36} {25, 27, 42, 44}
{29, 31, 49, 77} {30, 32, 51, 56} {33, 35, 61, 79} {69, 71, 16, 37}
{48, 50, 78, 38} {43, 45, 75, 19} {26, 62, 41, 47} {72, 64, 57, 54}
{65, 67, 39, 52} {53, 60, 70, 66} {82, 83, 115, 116} {84, 85, 119, 120}
{88, 89, 128, 86} {90, 91, 134, 87} {92, 94, 97, 99} {96, 98, 102, 104}
{101, 103, 110, 113} {112, 114, 122, 125} {106, 108, 117, 121} {93, 95, 107, 109}
{124, 126, 141, 143} {127, 129, 145, 151} {146, 138, 148, 118} {131, 133, 152, 157}
{162, 154, 132, 142} {147, 139, 130, 156} {161, 111, 155, 158} {137, 140, 144, 159}
{73, 23, 100, 160} {153, 63, 76, 105} {136, 74, 59, 150} {12, 123, 149, 55}
{163, 58, 135, 68}
{0, 2, 63, 75} {1, 4, 8, 23} {3, 6, 12, 59} {7, 10, 19, 71}
{11, 14, 26, 81} {13, 16, 30, 74} {15, 18, 39, 67} {28, 31, 55, 22}
{17, 20, 50, 72} {21, 24, 64, 79} {37, 41, 46, 27} {56, 60, 66, 32}
{38, 42, 52, 76} {69, 53, 36, 48} {43, 25, 73, 58} {82, 84, 111, 132}
{83, 85, 113, 155} {86, 88, 118, 144} {87, 89, 150, 162} {90, 93, 99, 146}
{92, 95, 104, 156} {91, 94, 106, 161} {97, 100, 114, 158} {102, 105, 126, 154}
{107, 110, 134, 101} {130, 133, 163, 103} {139, 143, 149, 115} {121, 125, 135, 159}
{141, 145, 98, 136} {124, 108, 96, 151} {33, 34, 117, 119} {77, 78, 116, 120}
{57, 49, 160, 152} {44, 80, 122, 148} {131, 123, 70, 62} {138, 140, 65, 68}
{153, 9, 5, 147} {29, 112, 128, 47} {40, 142, 127, 54} {45, 129, 157, 35}
{51, 137, 61, 109}
{0, 1, 122, 162} {2, 4, 90, 92} {3, 5, 94, 97} {6, 8, 98, 101}
{7, 9, 100, 104} {10, 12, 106, 108} {11, 13, 110, 112} {14, 16, 116, 144}
{15, 17, 118, 123} {18, 20, 128, 146} {19, 21, 130, 151} {23, 25, 135, 95}
{24, 26, 138, 82} {30, 32, 85, 96} {33, 35, 89, 102} {36, 38, 99, 111}
{39, 42, 133, 103} {44, 47, 143, 105} {28, 31, 129, 139} {34, 37, 140, 86}
{54, 57, 87, 109} {41, 45, 132, 113} {49, 53, 141, 107} {46, 50, 142, 84}
{75, 79, 114, 152} {69, 73, 117, 134} {136, 137, 56, 58} {119, 120, 76, 80}
{126, 163, 48, 52} {148, 150, 72, 74} {121, 157, 55, 68} {88, 124, 81, 71}
{149, 153, 77, 43} {147, 66, 78, 161} {91, 29, 63, 155} {127, 65, 62, 131}
{115, 22, 60, 159} {154, 61, 51, 160} {27, 145, 156, 67} {70, 83, 125, 59}
{40, 158, 64, 93}
{82, 84, 14, 16} {83, 85, 18, 20} {86, 88, 22, 28} {87, 89, 25, 53}
{90, 92, 29, 34} {91, 93, 37, 55} {94, 96, 41, 62} {95, 97, 43, 3}
{98, 100, 48, 74} {99, 101, 52, 66} {102, 104, 75, 4} {103, 105, 77, 8}
{106, 108, 5, 17} {109, 112, 39, 9} {110, 113, 45, 7} {114, 117, 51, 61}
{118, 121, 60, 6} {119, 122, 70, 10} {111, 115, 38, 19} {124, 128, 56, 80}
{127, 131, 2, 40} {129, 133, 13, 30} {116, 35, 36, 120} {135, 54, 58, 141}
{138, 57, 63, 146} {140, 59, 67, 150} {149, 68, 78, 161} {153, 46, 24, 163}
{107, 26, 42, 125} {134, 27, 69, 126} {148, 21, 23, 142} {156, 49, 73, 130}
{154, 47, 81, 145} {155, 65, 33, 144} {159, 15, 31, 147} {132, 32, 71, 136}
{72, 143, 137, 12} {50, 139, 123, 76} {160, 79, 162, 0} {1, 157, 11, 151}
{44, 158, 64, 152}
{82, 1, 27, 110} {83, 2, 30, 113} {84, 3, 33, 116} {85, 4, 36, 119}
{86, 5, 39, 122} {89, 8, 47, 87} {90, 10, 14, 98} {91, 11, 23, 107}
{92, 12, 38, 138} {93, 13, 40, 143} {95, 15, 45, 153} {101, 21, 75, 88}
{99, 20, 24, 121} {104, 25, 31, 160} {114, 35, 44, 96} {97, 18, 32, 158}
{105, 26, 42, 134} {130, 51, 72, 100} {108, 29, 53, 102} {147, 68, 16, 120}
{127, 49, 55, 103} {124, 46, 56, 162} {135, 57, 19, 118} {48, 131, 132, 52}
{50, 133, 139, 58} {54, 137, 145, 64} {59, 142, 154, 73} {66, 149, 163, 0}
{43, 126, 144, 63} {17, 156, 148, 41} {60, 117, 141, 34} {9, 128, 106, 61}
{74, 157, 109, 28} {7, 140, 161, 69} {150, 70, 159, 80} {151, 76, 125, 81}
{115, 37, 129, 71} {79, 136, 6, 152} {111, 65, 22, 94} {62, 146, 155, 77}
{123, 78, 112, 67}
{0, 83, 111, 30} {1, 84, 114, 33} {2, 85, 117, 36} {3, 86, 124, 46}

$\{4, 88, 92, 12\}$	$\{5, 89, 96, 17\}$	$\{6, 90, 98, 19\}$	$\{7, 91, 103, 23\}$
$\{10, 94, 110, 34\}$	$\{11, 95, 113, 59\}$	$\{9, 93, 119, 55\}$	$\{15, 99, 126, 65\}$
$\{13, 97, 127, 71\}$	$\{16, 101, 105, 38\}$	$\{21, 106, 112, 77\}$	$\{40, 125, 134, 22\}$
$\{43, 128, 140, 31\}$	$\{24, 109, 130, 76\}$	$\{35, 120, 150, 8\}$	$\{47, 133, 138, 37\}$
$\{49, 135, 141, 25\}$	$\{58, 144, 154, 14\}$	$\{56, 142, 104, 39\}$	$\{107, 26, 146, 68\}$
$\{129, 48, 87, 45\}$	$\{131, 51, 137, 57\}$	$\{122, 42, 132, 53\}$	$\{147, 67, 161, 81\}$
$\{121, 41, 139, 63\}$	$\{160, 70, 162, 50\}$	$\{158, 78, 108, 52\}$	$\{82, 74, 149, 64\}$
$\{153, 60, 118, 66\}$	$\{73, 157, 20, 123\}$	$\{32, 143, 18, 152\}$	$\{80, 69, 145, 102\}$
$\{155, 75, 54, 148\}$	$\{72, 156, 159, 79\}$	$\{28, 100, 115, 61\}$	$\{151, 44, 136, 29\}$
$\{27, 116, 62, 163\}$			
$\{1, 87, 49, 148\}$	$\{82, 2, 103, 26\}$	$\{83, 3, 111, 47\}$	$\{84, 4, 113, 52\}$
$\{85, 5, 115, 75\}$	$\{89, 9, 145, 76\}$	$\{90, 11, 102, 72\}$	$\{91, 12, 110, 38\}$
$\{92, 13, 125, 65\}$	$\{88, 10, 97, 78\}$	$\{94, 16, 104, 70\}$	$\{96, 18, 144, 79\}$
$\{15, 98, 17, 101\}$	$\{29, 112, 69, 109\}$	$\{44, 127, 6, 123\}$	$\{24, 108, 30, 114\}$
$\{22, 106, 31, 116\}$	$\{23, 107, 33, 118\}$	$\{21, 105, 35, 119\}$	$\{51, 135, 71, 99\}$
$\{42, 126, 63, 150\}$	$\{7, 163, 59, 151\}$	$\{50, 134, 80, 122\}$	$\{55, 139, 28, 121\}$
$\{8, 93, 20, 154\}$	$\{39, 124, 56, 100\}$	$\{45, 130, 64, 156\}$	$\{74, 159, 25, 129\}$
$\{77, 149, 34, 143\}$	$\{0, 86, 14, 120\}$	$\{81, 147, 48, 142\}$	$\{66, 67, 157, 158\}$
$\{53, 54, 152, 153\}$	$\{57, 60, 146, 161\}$	$\{162, 137, 46, 73\}$	$\{131, 160, 62, 43\}$
$\{133, 140, 32, 37\}$	$\{132, 27, 141, 36\}$	$\{136, 61, 117, 40\}$	$\{19, 138, 58, 95\}$
$\{41, 155, 68, 128\}$			

□

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