Sixth International Olympiad in Theoretical, Mathematical and Applied Linguistics

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Solution of the Problem of the Team Contest

The syllables of Chinese consist of three parts: onset (initial consonant, which may be missing as in 3B), rhyme (all following sounds) and tone. Cantonese tones can be thought of as having two distinct qualities: height (high or low) and contour (rising, level or falling).

	rising	level	falling
high	35	3	53
low	13	2	21

(a) To use a fanqie transcription in Cantonese, A's onset and tone height are combined with B's rhyme and tone contour. But if A's (and X's) tone is low, X's onset, if a stop, must always be aspirated if B's (and X's) tone is rising (13) or falling (21), and unaspirated if it is level (2).

(b) Certainly the onset was from the A character, and the rhyme from B. But the aspiration rule is strange. Probably it was not part of the original fanqie system. Maybe the tone came from only one of the two characters? That has to be B, because the old rule should give correct results in only one transcription.

Thus the original simple rule for fanqie was: A's onset is combined with B's rhyme and tone. Only transcription 11 can be read now using this rule.

(c) Looking at the syllables with a sonorant onset, we see that they are always in a low tone (13, 2 or 21). Assuming that all voiced consonants evolved alike in Cantonese, we may conclude that what is in a low tone now, had a voiced onset earlier. This is also true of the character of the example from Wu. What is said in **(d)** supports this idea.

Thus the characters whose onsets were voiced are: 1X and 1A, 2X (=6B) and 2A, 3X and 3A, 3B (if it had an onset at all), 4X and 4A, 5X and 5A, 7B (=14A), 9X and 9A, 14X, 15X and 15A, 16B.

Voiced stops became aspirated if the tone was rising or falling, and unaspirated if it was level.

(d) The contours of the Cantonese tones correspond to the three tones of Classical Chinese; tone height is an innovation brought about by the evolution of the voiced consonants.

Now we can explain why fanqie transcriptions should be read in Cantonese the way they are. The X character has the same tone height as A because it got its onset from A, and height in Cantonese is determined by the voicing of the onset in Classical Chinese. But if the onset was a voiced stop, it could evolve in different ways in X and A, because its aspiration was determined by the tone contour, which X got from B, and it could differ from A's contour.

(e) In Mandarin onsets and rhymes are not combined in such a straightforward way as in Cantonese. It can be noted that after **x́** (**ǩ**, **ǩ$^{\mathbf{h}}$**) we always find **i** or **y**, whereas **x** (**k**, **k$^{\mathbf{h}}$**), **s** (**c**, **c$^{\mathbf{h}}$**) and **ṣ** (**ç**, **ç$^{\mathbf{h}}$**) are never followed by these vowels.

We already know that the onset came from A and the rhyme from B. When the constraint above came into being,

- **i** was lost and **y** became **u** after **ʂ** (**ɕ**, **ɕʰ**);
- **x** (**k**, **kʰ**) and **s** (**c**, **cʰ**) became **ɤ́** (**ǩ**, **ǩʰ**) before **i** or **y**.

These are also the rules that we must apply when using a fanqie transcription in Mandarin. However,

- if A's onset is **ɤ́** (**ǩ**, **ǩʰ**) and B's rhyme starts with neither **i** nor **y**, we can't determine what X's onset is;
- if B's onset is **ʂ** (**ɕ**, **ɕʰ**) and A's onset is none of these, we can't determine what X's rhyme is.

(f) On the basis of the tone of the Cantonese syllable we can determine whether the onset was voiced or not in Classical Chinese. In Mandarin the tones developed as follows:

- rising: 51 if the onset was voiced but not a sonorant, 214 otherwise;
- level: 51 (always);
- falling: 5 if the onset was voiceless, 35 otherwise.

We see that the contour is not preserved here. Voiced stops became aspirated if the tone was falling, and unaspirated if it was level or rising.

In fanqie transcriptions read in Mandarin the tones work as follows:

	5, 35	214	(F, H−)^{51}	(H+, L)^{51}
5	5	214	214, 51	51
L^{35}	35	214	214, 51	51
(F, H+)^{35}	35	51	51	51
L^{214}	35	214	214, 51	51
(F, H±)^{214}	5	214	214, 51	51
L^{51}	35	214	214, 51	51
H+^{51}	5	214	214, 51	51
(F, H−)^{51}	5, 35	214, 51	214, 51	51

Here L stands for a sonorant, F for a fricative, H− for an unaspirated and H+ for an aspirated stop. Thus most of the time X's tone in Mandarin can't be derived unambiguously from A's and B's tones, though in some cases it can.

(g) Syllables with a sonorant onset and tone 5 or with an unaspirated onset and tone 35 should not exist in Mandarin (if they do, then the rules must have had exceptions).

(h) 46: **21**, 47: **51**, 48: **13**, 49: **35**, 50: **53**, 51: **2**.

(i) 52 **tʰai**^{53}, 53 **siu**^{3}, 54 **loŋ**^{2}, 55 **paai**^{2}.

(j) 56 **sai**^{51}, 57 **kian**^{214}, 58 **ʂaŋ**^{214}, 59 **pʰai**^{214}, 60 **ɤ́yan**^{51}, 61 **ǩʰyan**^{214}, 62 **ɤ́ia**^{51}, 63 **xan**^{51}, 64 **ɕou**^{51}, 65 **naŋ**^{35}, 66 **sai**^{5}.